Epidemiology and Management of Pre- and Postharvest Diseases of Fresh Market Stone Fruits

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Objectives

1. Evaluate bloom and preharvest applications of new fungicides and biological products as compared to registered fungicides for control of brown rot blossom blight and pre- and postharvest brown rot fruit decay, as well as for gray mold and powdery mildew.
   a. Natural incidence of blossom blight and fruit decay (e.g., V-10116, V-10135).
   b. Bloom spray treatments under defined wetness periods using high-angle sprinkler irrigation.
   c. Establishment of a new orchard at KAC with high-pressure overhead irrigation.
   d. Resistance management programs – mixtures of different fungicide classes.
   e. Efficacy of new fungicides against powdery mildew (e.g., V-10118, Quintec) and peach leaf curl.
2. Evaluate nectarine and peach cultivars for natural resistance against brown rot blossom blight and fruit rot.
3. Determine the efficacy of new fungicides and biological products as postharvest treatments.
   a. Continued evaluation of new fungicides (Penbotec and Pristine) in laboratory and experimental packingline studies, as well as evaluations of the newly registered fungicide Judge in commercial packlines. Evaluation of compatibility of Pristine with postharvest fruit coatings will also be done.
   b. Evaluation of the bio-fumigant (*Muscodor albus*) and other biologicals for decay control of stone fruits.
4. Evaluate new postharvest application methods, including in-line drenching systems, and roller-bed applications.
5. Management of sour rot of stone fruits caused by *Geotrichum candidum*.
   a. Collection and characterization of fungal isolates from soil and decayed fruit with sour rot-like symptoms.
   b. Evaluation of management strategies for sour rot, including sanitation treatments with chlorine and ozone, and pre-and postharvest fungicide treatments. Test the new wettable powder formulation of propiconazole that is odorless after dilution.
   c. Cooperation with one registrant of propiconazole to pursue registration of the fungicide for postharvest use on stone fruits.

d. Baseline sensitivities of *G. candidum* to propiconazole (WP formulation).

6. Establish baseline sensitivities of fungicides (EC_{50} values) using spiral gradient dilution technology and monitor for resistance in target pathogen populations for new fungicides (pyrimethanil and pyraclostrobin/boscalid).

Summary Outline

1) Fungicide treatment effects in brown rot blossom blight and fruit rot control were highly significant on three stone fruit cultivars. All fungicides evaluated including the registered products Pristine, Elevate, Vangard, Elite, Orbit (and other products of propiconazole such as Propimax and GF1798), and a new liquid formulation of Indar (i.e., Enable), as well as the new materials Scala, V-10116 (metconazole, an SBI fungicide), V-10135 (new class), and new pre-mixtures (e.g., USF2010 and USF2014) were all highly efficacious and all significantly reduced the incidence of brown rot blossom blight and fruit decay as compared to the control. Highly effective preharvest rotational products for the SBIs are still needed other than the anilinopyrimidines (e.g., Scala and Vangard) that break down under high temperature and humidity. Pre-mixtures and V-10135 potentially may fill this void. Furthermore, because of a change in the registration status, re-establishment of preharvest uses of Rovral beyond blossom treatments has been requested and is pending review.
2) In postharvest dip studies, new experimental compounds were evaluated. The new-class material V-10135 was very effective against brown rot and gray mold, but was ineffective against Rhizopus rot. A new natural compound by DuPont was very effective against gray mold and had intermediate efficacy against brown rot and Rhizopus rot. A natural compound from Valent Biosciences was ineffective against all three decays.
3) BASF is still tentatively pursuing registration of Pristine for postharvest use on stone fruit. Concerns with postharvest usage in the United States and the impact on worldwide maximum residue limits (MRLs) have been discussed. In postharvest experimental packingline studies, selected rates of Pristine were evaluated and lower rates were shown to be effective in controlling brown rot and gray mold with an efficacy similar to Scholar, Judge, or Penbotec. Lower rates, however, were ineffective against Rhizopus rot.
4) For control of sour rot, propiconazole was evaluated in detailed studies on peach and nectarine cultivars using the Orbit EC and Mentor WP formulations for pre- and postharvest treatments, respectively. Preharvest treatments (4 fl oz/100 gal/A) generally significantly reduced the incidence and severity of sour rot, however, postharvest treatments at the 2-oz rate were more effective. In addition, postharvest in-line drench applications were equally effective or more effective than low-volume CDA applications. Results for residue analyses of fruit samples from these experiments are pending.
5) In postharvest wash studies that were conducted on the experimental packingline, sour rot contamination on nectarine and peach fruit was progressively reduced with increasing wash durations and with the addition of a neutral cleaner. These wash treatments were more effective on the smooth-skinned nectarine fruit as compared to peach fruit. Still, none of the wash treatments was as effective as a postharvest treatment with propiconazole. Postharvest sanitation washes of fruit, however, will be an important component of an integrated approach to the management of sour rot. Currently we are developing the in-line drench system (with Scholar and chlorine) over a roller bed to minimize packingline contamination that is commonly observed with roller brush systems.

6) In evaluations of several varieties, the incidence of sour rot was as high as 5% for harvested fruit upon arrival at the packinghouse. Due to the high incidence of sour rot on stone fruit in the 2006 season and based on our studies, a Section 18 emergency registration (Crisis Exemption) was granted for propiconazole in August 2006. A Section 3 registration is being pursued through the IR-4 program. In September, propiconazole was given an A priority for postharvest registration on stone fruit.
7) Construction of a sensory evaluation lab at KAC is moving forward and construction was initiated in the fall of 2006.

Introduction

Blossom blight and preharvest brown rot control. Currently, fungicides are the most effective means for control of brown rot of blossoms and fruit. Some fungicides have pre-infection (protective) and post-infection (suppressive) activity. Thus, our research has shown that a single, properly timed fungicide application can reduce blossom blight to zero or near zero levels. Broad-spectrum fungicides such as Rovral and Topsin-M, and more narrow-spectrum SBI- fungicides such as Orbit, Elite, Indar, and Rally, as well as the anilinopyrimidines Vangard and Scala, Pristine (pre-mixture of two single-site materials), and the hydroxyanilide Elevate are available in California that are very effective for control of brown rot. The newer fungicides were registered based on research in our laboratory after older ones were either canceled or re-labeled (e.g., iprodione - Rovral), preventing their preharvest use on all stone fruit crops. Currently, we are developing new products with new modes of action to ensure that highly effective materials will always be available to the stone fruit industry. We have also developed use strategies for fungicide usage. Blossom and preharvest disease management practices based on new single-site mode of action materials are prone to select resistant populations of target pathogens. Thus, new fungicides need to be used in rotations or mixtures of different classes of fungicides. Resistance management practices initiated at the onset of the fungicides' introduction should help to prevent the selection of resistant populations to any given class of fungicide. Thus, in 2006 we have continued to conduct comparative blossom and preharvest efficacy studies with registered and new fungicide treatments. Fungicides evaluated represented several different chemical classes: the sterol biosynthesis inhibitors Orbit (and other formulations of propiconazole such as Propimax and GF 1798), Elite, Endorse (a new formulation of fenbuconazole - Indar), and V-10016 (metconazole); the anilinopyrimidines Vangard and Scala; the premixes Pristine (the strobilurin pyraclostrobin plus the carboxyanilide boscalid), USF2010 (the SBI tebuconazole plus the strobilurin trifloxystrobin), and USF2014 (the anilinopyrimidine pyrimethanil plus the strobilurin trifloxystrobin); as well as the experimental V-10135 belonging to a new class of fungicides.

Postharvest decay control. We continued to evaluate different fungicides, as well as biological controls and natural compounds with the goal of finding suitable postharvest treatments for all of the industry's needs for marketing high quality fruit. Over the years, we identified several highly active 'reduced-risk' fungicides and facilitated their registration by conducting IR-4 residue studies. Fludioxonil (Scholar) was fully registered for postharvest use in December 2002. In August 2005, fenhexamid (Judge) was registered in the state of California for postharvest use and was fully registered on stone fruit in June 2006. Penbotec and Pristine are being registered through the IR-4 program. Last year, however, BASF the registrant of Pristine delayed registration after European concerns about potential high MRL values on stone fruit with both pre- and postharvest applications at planned registered rates. Thus, we are currently involved in re-assessing residue tolerances and rates of postharvest applications of Pristine. This research will need to be continued in early 2007. Thus, several additional new fungicides will hopefully be available for postharvest use in the future to allow us to meet any market demand. Scholar is highly effective against brown rot, gray mold, and Rhizopus decays, whereas Elevate, Penbotec, and Pristine (at low postharvest rates) are mainly effective against gray mold and brown rot. Additionally, another fungicide called Mentor is being developed through the IR-4 program (see below). With several highly effective and environmentally safe postharvest fungicides available in the future and with an expanding arsenal of preharvest fungicides, it is important to apply proper fungicide stewardship. Thus, our research is also focussing on strategies to prevent fungicide resistance in pathogen populations. Determining fungicide sensitivity levels in fungal isolates is critical to detect any changes in sensitivity in pathogen populations. For this, we established baseline sensitivities of *M. fructicola*, *B. cinerea,* and *G. candidum* against some of the newer fungicides. In addition to evaluating new postharvest fungicides and integrating them into a management program, we have also been evaluating different postharvest application methods and the compatibility of fruit coatings with these fungicides. This is done to ensure efficacious fungicide usage, to make treatments cost-effective to packers, especially with expensive materials such as Scholar, and to improve the appearance of treated fruit.

Sour rot, caused by the fungus *Geotrichum candidum,* is a postharvest decay that is associated with fruit injuries and poor sanitation and harvest practices. It mainly occurs on ripe fruit and thus, the incidence of this decay has become a major concern on pre-conditioned or tree-ripened fruit. In 2006, however, sour rot and sour rot-like decays were very common in all fruit handling systems. Wet weather in the spring contributed to high populations levels. In our previous studies on the postharvest management of sour rot we concluded that the incidence of sour rot can be reduced by fruit sanitation washes, but not eliminated. Washes of equipment with sodium hypochlorite and quaternary ammonium compounds were found to be helpful as well since we previously demonstrated that *G. candidum* can survive on brushes and sponge rollers. In evaluations of preharvest fungicide treatments, only Orbit (propiconazole) significantly reduced the incidence of postharvest sour rot most of the time on many varieties. None of the other currently registered and new postharvest fungicides reduced the incidence of this decay. Postharvest treatments with propiconazole (Mentor) were found to be the most effective and consistent method for managing sour rot. Due to the high incidence of sour rot on stone fruit in the 2006 season and based on our studies, a Section 18 emergency registration (Crisis Exemption) was granted for propiconazole in August 2006. A Section 3 full registration is being pursued through the IR-4 program. Thus, in 2006 we conducted a series of detailed studies that included pre-and postharvest fungicide treatments, as well as postharvest sanitation washes to support the emergency registration for Mentor. This was done also to develop an effective integrated management strategy for sour rot with tools currently available and with postharvest use of Mentor. Because industry representatives were concerned about unacceptable odors associated with the field formulation of propiconazole (an EC formulation), the registrant provided an odorless WP formulation that alleviated this issue.

Management of powdery mildew and peach leaf curl. In 2006 trials were also conducted on the management of powdery mildew and peach leaf curl. Due to the cool, wet spring in 2006, disease incidence for powdery mildew was very low in our research plot and no data could be obtained. Dormant spray treatments were conducted for management of peach leaf curl. Due to serious outbreaks of this disease in recent years, treatments and rotations of copper products and Ziram, as well as comparisons of one and two applications were evaluated.

Materials and Methods

I. Blossom blight and preharvest studies for brown rot control

Evaluation of fungicides for management of brown rot blossom blight and preharvest fruit decay. One plot was established at the Kearney Agricultural Center (KAC) in Parlier, CA, to evaluate fungicides for control of brown rot blossom blight and fruit decay on Red Diamond nectarine as well as Elegant Lady and Ryan Sun peach. Fungicides that were applied to trees using an air-blast sprayer calibrated for 100 gal/A and application dates are indicated in Fig. 1 of the Results section of this report. The performance of fungicides applied at 80-90% bloom for Red Diamond nectarines, 30-40% for Elegant Lady peaches, and 20-30% bloom for Ryan Sun peaches was based on natural rainfall. Randomized sub-plots of four single-tree replications for each treatment were used. Incidence of brown rot blossom blight caused by *M. fructicola* was recorded on May 14. For this, 200 blossoms were evaluated for blight for each single-tree replication and treatment.

This orchard at KAC was also used for the evaluation of preharvest treatments. Applications were made in the field using an air-blast sprayer (100 gal/A) on 6-21 and 6-28-06 to Red Diamond nectarine, on 7-11 and 7-18 to Elegant Lady peach, and on 8-16 and 8-23-6 to Ryan Sun peach using an air blast sprayer at 100 gal/A. Fungicides evaluated are indicated in Fig. 2. Four boxes of 48 fruit each were harvested for each treatment (one per single-tree replication). Fruit were packed in commercial boxes and stored for approximately 7 days at 1 C and then at 20C for 7 days. Fruit were evaluated for incidence and severity (lesion diameter) of decay.

Evaluation of fungicides for management of peach leaf curl. Fungicides were applied in an experimental Fay Elberta orchard at UC Davis as dormant treatments on 12-19-05 and 1-24-06 using an air-blast sprayer at 100 gal/A. Trees were evaluated for disease in April, 2006. For this, 100 shoots for each tree were rated for the presence of leaf curl.

II. Postharvest management studies for brown rot, gray mold, and Rhizopus rot.

Laboratory and experimental packingline studies using postharvest fungicide treatments for control of brown rot, gray mold, Rhizopus rot, and sour rot. The new natural product DPX LEM17-045 and the experimental fungicide V-10135 were evaluated on July Flame peaches in the laboratory and efficacy was compared to that of Scholar. For this, wound-inoculated fruit (8-12 fruit for each of 4 replications) were dipped into aqueous solutions for 30 sec. and then incubated for 6 days at 20C and >95% RH. After this incubation period, lesion diameter (severity) and disease incidence were recorded.

In an experimental packingline study on Red Diamond nectarines using CDA applications over a brush bed at 25 gal/200,000 lb fruit, the efficacy of propiconazole (using either the EC or the WP formulation), Scholar (using the new 230SC formulation), and mixtures of propiconazole with Scholar or Elevate were evaluated. Fruit that were wound-inoculated (wounds 1 x 1 x 0.5 mm) with either *G. candidum* ($3x10^5$ spores/ml), *M. fructicola, B. cinerea,* or *R. stolonifer* ($3x10^4$ spores/ml each) were treated 13-16 h after inoculation and then incubated for 6 days at 20C. Four replications of 12-24 fruit were used in the packingline studies. The efficacy of Pristine was evaluated in two experimental packingline studies on Ryan Sun peaches and Summer Fire nectarines. In CDA applications, different rates of the fungicides (125-1000 ppm) were compared to the efficacy of Scholar and Penbotec. Wound-inoculated fruit ($3x10^4$ spores/ml) were treated after 13-16 h and then incubated for 6 days at 20C and >95% RH.

In delayed applications, CDA treatments and in-line drenches over a roller bed were compared on Casselman plums in another experimental packingline study. CDA applications were done at 25 gal/200,000 lb. Treatment rates for CDA applications expressed in ppm are the equivalent amount of active ingredient applied in 100 gal/200,000 lb fruit. In-line drench applications were done with fungicide rates/100 gal. Fruit were wound-inoculated with *M. fructicola* or *B. cinerea*, incubated for 13-16 h at 20C and then for 24 h at 2C, and treated with Scholar, Pristine, Penbotec, or a Scholar-Pristine mixture. Fruit were then incubated for 6 days at 20C and >95% RH.

III. Management of sour rot of stone fruits caused by *Geotrichum candidum*.

Collection and characterization of fungal isolates from decayed fruit with sour rot-like symptoms. Fungal isolations were performed from nectarine and peach fruit collected from different packinghouses. These fruit exhibited typical symptoms of sour rot (thin layer of whitish mycelium covering the decay, vinegary odor of fruit) or sour rot-like symptoms. Yeast-like colonies growing on the isolation plates were re-streaked on agar media and single colonies were isolated. Isolates were characterized morphologically and in pathogenicity assays. Ripe nectarine or peach fruit were wounded and 20-µl drops of spores ($2x10^7$ spores/ml) were added to the wound. All fruit were treated with Scholar to prevent the development of other decays such as brown rot, gray mold, or Rhizopus rot. Fruit were incubated in closed plastic boxes to maintain a high relative humidity and evaluated for the development of decay after 8-10 days.

Pre- and postharvest treatments for control of sour rot. Propiconazole was used in preharvest (Orbit 3.6EC, Propimax 3.6EC, GF1798 1.4MEC) and postharvest treatments (Mentor 45WP). Elite was included in one trial. Trials were done with Summer Fire and Red Diamond nectarines as well as Elegant Lady, July Flame, and Ryan Sun peaches. Treatments were applied at selected preharvest intervals as indicated in the figures in the Results section. These preharvest treatments were evaluated by itself or in combination with postharvest sanitation wash treatments over a brush bed (using water, chlorine, or a chlorine-neutral cleaner mixture) and/or postharvest propiconazole (Mentor) treatments over a brush or roller bed. The efficacy of wash treatments was also evaluated by itself. In addition, in several experiments, different timings of postharvest wash treatments (15, 30, 60 sec) were compared. Postharvest treatments with Mentor were done using CDA, in-line drench, or dip applications at rates of 64 ppm or 128 ppm (equivalent to 2 or 4 fl oz/100 gal of the 3.6EC formulation of propiconazole, respectively. Thus, treatment rates for CDA applications expressed in ppm are the equivalent amount of active ingredient applied in 100 gal/200,000 lb fruit). CDA applications (generally at 25 gal/200,000 lb) were done over a brush bed or over a roller bed. CDA and dip applications were done in diluted fruit coatings (50% and 10% Decco D251, respectively), whereas aqueous in-line drench applications were followed by CDA applications with the fruit coating. All fruit were also treated with Scholar

(8 oz/200,000 lb) that was either mixed with Mentor in the fungicide solution or included in the fruit coating. Scholar is ineffective against sour rot and the treatment was necessary to inhibit other decays (brown rot, gray mold. Rhizopus rot) that would have otherwise overgrown the sour rot lesions. Fruit were either wound- or drop- inoculated with conidia of *G. candidum* (20 µl of $3x10^5$ to $1x10^6$ conidia/ml as specified in the figure legends). Each fruit was wounded at three sites and 10-24 fruit were used for each of four treatment replications (30-72 inoculations/replication). Inoculations were done 12-18 h before treatment of fruit. Drop-inoculated fruit were wounded after treatment by stabbing the marked inoculation site 5-6 times with toothpicks (ca. 3-4 mm deep) and a fresh toothpick was used for every inoculation site. These drop-inoculation studies were done to evaluate the efficacy of treatments in removing sour rot contamination from fruit. Thus, efficacy using this latter inoculation method was based on decay development from inoculum that was not removed and remained viable after the treatment. Fruit were then incubated at 20C and >95% RH for 5 to 7 days. In one study, the efficacy of Mentor was compared using different fruit coatings (emulsified mineral oil, polyethylene-based, vegetable-oil based, and carnauba-based commercially available coatings). In this study wound-inoculated fruit was dipped treated for 30 sec. For evaluation of sour rot, the incidence of decay was determined based on the number of inoculations that developed sour rot symptoms of the total number of inoculations done per replication. Decay severity was also evaluated and was based on a rating scale from 0 (=no symptoms) to 4 (=enlarging soft lesion with white sporulation).

Statistical analysis of data. Data for disease incidence were arcsin transformed before analysis. Data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures of SAS 9.1.

Results and Discussion

I. Blossom Blight and Preharvest Brown Rot Control

Efficacy of fungicides for management of blossom blight. Unlike in most other years, bloom of the three stone fruit cultivars in our orchard at UC-KAC occurred over a relatively long period in the spring of 2006. Therefore, treatments had to be applied separately to each cultivar. This year, the performance of blossom treatments was only evaluated under natural rainfall conditions during bloom. Our new stone fruit orchard where overhead sprinkler irrigation has been installed to provide simulated rain treatments will be available for use in the spring of 2007. Still, due to the wet spring and favorable temperatures, blossom blight disease levels were higher than in most years.

Disease incidence at evaluation time was 4.3%, 10.6% and 13.8% for non-treated trees of Red Diamond nectarine, Elegant Lady peach, and Ryan Sun peach, respectively (Fig. 1). Most fungicides in these single-application treatments were very effective in reducing the incidence of blossom blight. Overall, treatments were more effective on the nectarine where applications were done at 80-90% bloom as compared to 30-40% or 20-30% bloom for Elegant Lady and Ryan Sun peach, respectively. On all three stone fruit cultivars no disease was detected using Pristine, V-10116 (metconazole - a new SBI), or USF2014 (pre-mix of an anilinopyrimidine with a strobilurin). Additional highly effective treatments were Elevate (0.1-0.3% incidence), Propimax (propiconazole; 0-2% incidence), GF1798 (propiconazole; 0-2% incidence), Enable (a new formulation of fenbuconazole; 0-1.4% incidence), and USF2010 (pre-mix of an SBI and a strobilurin; 0-1.4% incidence). Scala and the mixture of Orbit and Abound had an intermediate efficacy. Among the registered fungicides, Vangard was the least effective treatment (1.4-6.9% incidence). Overall for all fungicides, the new-class material V-10135 was the least effective treatment and the most variable in its efficacy. Currently, registered fungicides that belong to five different classes, the SBI fungicides (Orbit, Elite, Indar, and Rally), the anilinopyrimidines (Vangard and Scala), the dicarboximides (Rovral/Oil), and the strobilurin-carboxyanilide mixture (Pristine) are treatments for immediate use in managing brown rot blossom blight.

Efficacy of preharvest fungicides for management of fruit decays. The efficacy of preharvest fungicides for control of fruit brown rot decay was evaluated at KAC using 8+1 day PHI applications. Similar to previous years, fungicides overall did not perform as well in reducing the natural incidence of brown rot decay on the later maturing Ryan Sun peach as compared to the earlier maturing Red Diamond nectarine and Elegant Lady peach, possibly due to the fact that fewer quiescent infections were established on the latter cultivars at application time. Natural incidence of brown rot decay on untreated trees was 64.1%, 49.1%, and 88.5% for Red Diamond, Elegant Lady, and Ryan Sun, respectively (Fig. 2). On the nectarine and Elegant Lady peach, most treatments were highly effective in reducing the incidence of brown rot. Scala was the least effective fungicide on the nectarine with 31.8% incidence, whereas the best treatment (Propimax) only had 4.2% incidence. On Elegant Lady peach, however, Propimax in addition to Scala and the Orbit-Abound mixture (rates of 2 fl oz-12.5 fl oz in this mixture) was less effective than the other treatments. The new Scala-Flint pre-mixture (USF2014) was highly effective, similar to the other pre-mixtures evaluated (i.e., Elite-Flint – USF2010, Pristine). These pre-mixtures will be important components in resistance management strategies. In contrast to treatments for blossom blight control, the new fungicide V-10135 was highly effective in reducing the incidence of fruit brown rot, similar to the SBI fungicides. As indicated above, the efficacy of all treatments was much lower on Ryan Sun peach as compared to the other two stone fruit cultivars. Incidence of brown rot ranged from 32.8% (Enable) to 68.9% (GF1798; a formulation of propiconazole).

Results on these preharvest fungicide treatments are in agreement with our previous years' data. Thus, selected fungicides are consistent in their performance over the years and on different cultivars, and therefore are reliable preharvest treatments for the stone fruit industry for managing preharvest diseases, as well as helping to reduce postharvest decays. Highly effective preharvest rotational products for the SBIs are still needed other than the anilinopyrimidines (e.g., Scala and Vangard) that break down under high temperature and humidity. Pre-mixtures and V-10135 potentially may fill this void. Furthermore, because of a change in the registration status, re-establishment of preharvest uses of Rovral beyond blossom treatments has been requested and is pending review.

Evaluation of fungicides for management of peach leaf curl. In a trial on Fay Elberta peaches, the efficacy of selected fungicides applied during tree dormancy was compared in one- and two-spray application programs. Treatments with Ziram, either alone or in a mixture or rotation were the most effective in reducing the incidence of peach leaf curl (Fig. 3). Two applications of Ziram performed significantly better than a single application. Copper treatments alone were either not effective (Cuprofix – 2 applications) or had an intermediate efficacy (Nordox, Kocide). This lack of good efficacy was most likely because no oil was applied with the copper treatments to improve persistence. This was done, however, to compare the persistence and performance of materials without adjuvants added.

II. Postharvest decay control

Laboratory and experimental packingline studies using postharvest fungicide treatments for control of brown rot, gray mold, and Rhizopus rot. New materials were evaluated as dip treatments in a laboratory study. V-10135 was similarly effective against brown rot and gray mold as Scholar, but in contrast to Scholar, had no activity against Rhizopus rot (Fig.4). The experimental natural product from DuPont (DPX LEM17-045) had very good activity against gray mold, similar to Scholar. Brown rot was reduced by this material by 75% as compared to 100% decay incidence in the control, and the efficacy against Rhizopus rot was intermediate. Thus, although not as effective Scholar overall, this is a promising new natural product that deserves further evaluation. In contrast, another natural compound from Valent Biosciences was ineffective against all four decays (data not shown).

In an experimental packingline study, propiconazole was evaluated by itself and in mixtures with Scholar or Elevate. This was done because of the planned registration of propiconazole (Mentor) for sour rot control (see below). Possibly a mixture of Mentor and Scholar could manage brown rot, gray mold, Rhizopus rot, as well as sour rot. The results of this study indicate that sour rot was equally reduced to low levels using both formulations of propiconazole, the 3.6EC as well as the 45WP formulations. The incidence of sour rot was most effectively reduced by treatments that included propiconazole at a rate of 128 ppm (Fig. 5). The lower rate of 64 ppm that was used in one of the mixtures with Elevate was not as effective (see more detailed experiments on sour rot below). All treatments were highly effective against brown rot. For gray mold, propiconazole was the least effective material (as expected for an SBI fungicide), but still significantly reduced the incidence of decay. This fungicide also significantly reduced the incidence of Rhizopus rot, although not to the same extent as Scholar did. In contrast, in an experiment that was conducted in 2005, Mentor was not effective against Rhizopus rot and gray mold. Thus, the efficacy of propiconazole (Mentor) is inconsistent against these two decays.

Two studies were conducted with Pristine at different rates and efficacies were compared to those of Scholar and Penbotec. This was done because BASF, the registrant of Pristine, is still tentatively pursuing registration of Pristine for postharvest use on stone fruit. Concerns with postharvest usage in the United States and the impact on worldwide maximum residue limits (MRLs) have been discussed above. In both studies, the efficacy of Pristine increased with increasing rates between 125 and 1000 ppm (Figs. 6,7). Overall, to achieve a comparable efficacy to Scholar (at the 300-ppm, 8-oz rate) and Penbotec (at the 500-ppm rate), a rate of 250-500 ppm were required for Pristine to control brown rot and gray mold. The incidence of Rhizopus rot was significantly reduced from the control by all rates of Pristine and the efficacy of the 1000-ppm rate was similar to that of Scholar (Fig. 6) but lower rates had significantly higher levels of disease. No phytotoxicity using Pristine was observed in this experiment. Phytotoxicity has been found previously in some experiments, mainly when using very mature fruit.

The efficacy of Scholar, Pristine, and Penbotec was compared using CDA (25 gal/200,000 lb) and in-line drench applications. In this study, the efficacy of the fungicides was not consistently dependent on any of the two application methods (Fig. 8). Previously we demonstrated the superiority of drench applications as compared to low-volume spray applications. In addition, in this year's trial, none of the fungicides reduced decay to zero levels. This was probably due to the fact that fruit were incubated for a longer time before treatment (i.e., 13-16 h at 20C and then 24 h at 2C) and thus, infections had already progressed. In addition fruit was very mature when the experiment was conducted.

Thus, our studies were part of an ongoing effort to develop and register new "reduced-risk" postharvest treatments and to integrate the new materials in resistance management strategies that include the use of proper rates and application methods. Currently, fludioxonil (Scholar) and fenhexamid (Elevate, now called Judge for postharvest uses) are fully registered for postharvest use on stone fruit in California. Pyrimethanil (Penbotec) is being registered through the IR-4 program and registration is expected for 2008. The reduced risk fungicides Scholar, Judge, Pristine, and Penbotec, their active ingredients belonging to five different chemical classes, will be essential for designing resistance management programs that will ensure the chemicals' effectiveness for years to come.

Incidence of sour rot in the 2006 season and identification of fungi associated with sour rot. The incidence of sour rot was high in 2006. Up to 5% of harvested fruit already showed sour rot symptoms upon arrival at the packinghouse. This was most likely due to the extremely hot weather that occurred during part of the summer and uneven ripening from a protracted bloom. In our fungal isolations, *G. candidum* was the most prevalent pathogen isolated. Still, yeast-like fungi of different cultural morphologies also commonly grew on the isolation plates. To determine if these latter fungi could be primary pathogens, pathogenicity tests were performed. These studies indicated that *G. candidum* was more virulent than the other yeast fungi isolated. Several of the non-*Geotrichum* yeasts did not cause decay in any of the three studies conducted, whereas others caused decay only on very ripe ore severely stressed fruit.

Pre- and postharvest treatments for control of sour rot. The efficacy of pre- and postharvest fungicide treatments as well as of postharvest wash treatments is discussed together this section because several integrated studies were conducted that sometimes combined all these management strategies. Results for residue analyses of fruit samples from these pre- and postharvest experiments are pending.

Preharvest treatments were done with several products and formulations of propiconazole (Orbit 3.6EC, Propimax 3.6EC, GF1798 1.4MEC). In one trial on Red Diamond nectarines Elite and a mixture of Orbit with Abound were included. Preharvest treatments with propiconazole in most cases significantly reduced the incidence of sour rot when fruit were wound-inoculated after harvest (Figs. 9-16). Reductions of decay incidence as compared to the control ranged from ca. 10% to up to ca. 70% (treatment with Propimax in one trial on Elegant Lady peaches – Fig. 12). There was no consistent correlation between efficacy and formulation of propiconazole used (Figs. 9-12), preharvest timing interval (Figs. 9,10,14-16), application volume (100 or 400 gal/A; Fig. 9), or fruit type (nectarine or peach).

Postharvest sanitation wash treatments that were conducted on the experimental packingline were evaluated as part of a thorough fruit and equipment sanitation program in the packinghouse because sour rot-infected fruit on a packingline will contribute to contamination of other fruit during processing. Wash treatments were evaluated on preharvest treated and untreated fruit. These fruit washes to remove inoculum on the fruit surface (drop-inoculations before treatments) were generally more effective on nectarines (Figs. 9,10,18) than on peaches (Figs. 12-19). Still, there were inconsistencies where wash treatments of nectarines were not very effective (for example studies on Red Diamond nectarines – Fig. 11 or Summer Flare nectarines – Fig. 17). Longer wash times (60 sec) with chlorine were generally (Figs. 9,10), but not always (Fig. 19) more effective than shorter (15 sec) wash durations. Washes using chlorine plus a neutral cleaner were the most effective sanitation wash treatments, especially if long wash durations (60 sec) were used (Figs. 9,10,19) and these treatments were more effective in the two studies on nectarines (Figs. 9,10) than in the peach study (Fig. 19).

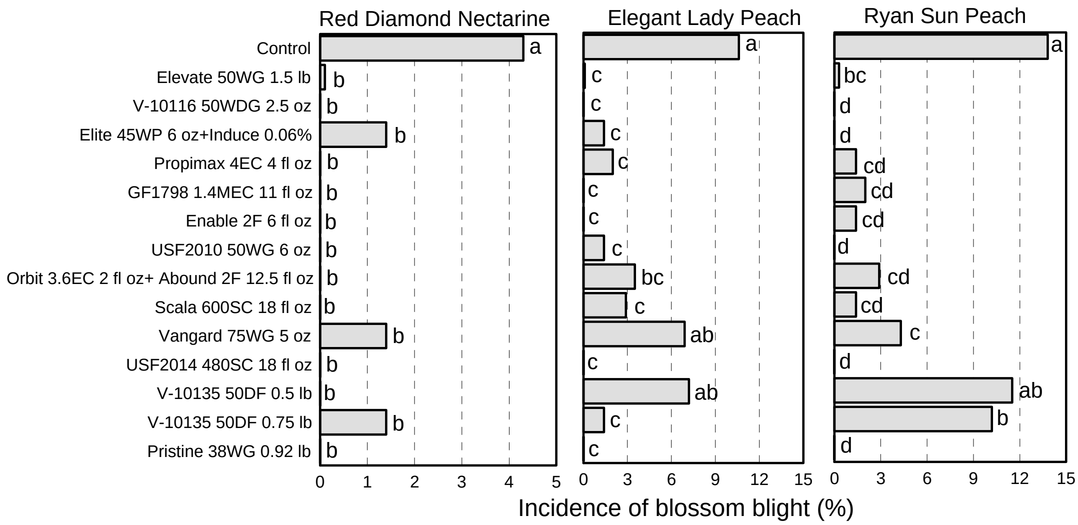
These results indicate that thorough sanitation wash treatments are an important strategy to remove contamination of sour rot from fruit, but they are generally not highly effective by themselves. Sour rot contamination on nectarine and peach fruit was progressively reduced with increasing wash durations and with the addition of a neutral cleaner. These wash treatments are, however, also important in reducing the build-up of inoculum on the packingline. Although not all inoculum is being removed from fruit, inoculum in the wash water is rapidly killed by chlorine and thus, cannot cause decay of healthy fruit. Currently we are developing the in-line drench system (with Scholar and chlorine) over a roller bed to minimize packingline contamination that is commonly observed with roller brush systems.

In postharvest fungicide treatments, Mentor 45WP (propiconazole) was applied as CDA, in-line drench, or dip treatments using rates of 64 or 128 ppm. The incidence of sour rot was consistently reduced to very low levels as compared to the control. At comparable rates, in-line drench or dip treatments were generally more effective using both inoculation techniques (wound-inoculation vs. drop-inoculation and wounding of fruit after treatment) than low-volume spray (CDA) applications (Figs. 11,13,14,16). CDA applications over a roller bed were equally effective than applications over a brush bed in the one study conducted (Fig. 10). The higher rate of 128 ppm was mostly (Figs. 12-17), but not always (Figs. 9,10,17,18,19) more effective than the lower rate of 64 ppm in the CDA applications. For the in-line drench applications both rates most times performed equally well (Figs.11,17-19). In addition, combinations of pre-and postharvest treatments were not additive and postharvest propiconazole treatments alone were equally effective as the combination treatments. This is presumably because during postharvest washing of the fruit before postharvest fungicide treatment, most of the preharvest residues on the fruit were removed.

The performance of Mentor was also evaluated using different fruit coatings in the treatment solution (Fig. 20). All treatments of Mentor with different fruit coatings significantly reduced the incidence of sour rot to very low values (<12%) as compared to 73% and 81% in the control treatments for each stone fruit cultivar evaluated. Still, slight statistical, but not always consistent differences were observed between some of the fruit coatings for the two cultivars tested (Fig. 20).

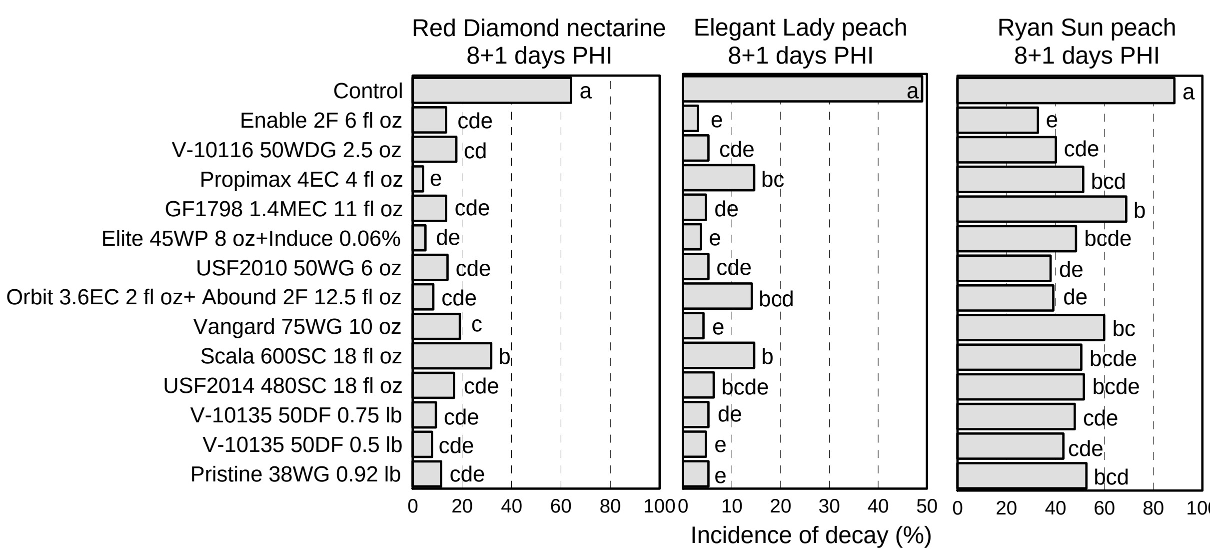
In summary, our studies on the management of sour rot indicate, as in previous years, that postharvest treatments with propiconazole (Mentor) are the most effective method to reduce the incidence of this decay. This emphasizes the importance of getting a postharvest registration for Orbit. Due to the high incidence of sour rot on stone fruit in the 2006 season and based on our studies, a Section 18 emergency registration (Crisis Exemption) was granted for propiconazole in August 2006. A Section 3 registration is being pursued through the IR-4 program. In September, propiconazole was given an A priority for postharvest registration on stone fruit. Still, there was variability in efficacy among our experiments. This emphasizes the fact that sour rot management has to be done as an integrated approach that includes proper handling of fruit, sanitation treatments of equipment and fruit, and preharvest applications with Orbit. All these practices are especially important for those stone fruit cultivars that are known to be highly susceptible to this decay and when pre-conditioned or tree-ripened fruit are marketed. In addition, Orbit and Mentor are not effective against other sour rot-like decays that were also observed in 2006. These sour rot-like decays that are caused by other species of yeast fungi are not controlled by any of the registered fungicides on stone fruit. Sanitation and proper handling practices are the only methods currently available to reduce these kinds of decays.

Fig. 1. Efficacy of fungicide treatments for management of brown rot blossom blight of nectarine and peach cultivars at the Kearney Agricultural Center



One application of each treatment was made in the field on 2-24-06 to Red Diamond nectarines (80-90% bloom), on 3-1-06 to Elegant Lady (30-40% bloom), and on 3-8-06 to Ryan Sun peach (20-30% bloom) using an air-blast sprayer (100 gal/A). Blossoms were evaluated for blossom blight on 5-14-06. There were four single-tree replications for each treatment.

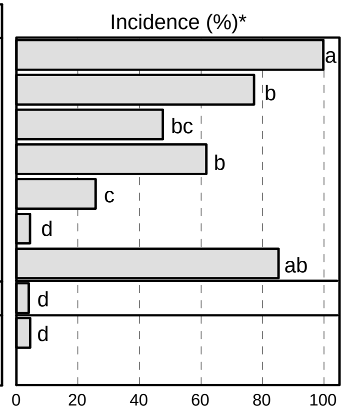
Fig. 2. Efficacy of preharvest fungicide treatments for management of fruit brown rot of nectarines and peach cultivars at the Kearney Agricultural Center
- Natural incidence of decay -



Applications were made in the field using an air-blast sprayer (100 gal/A) on 6-21 and 6-28-06 to Red Diamond nectarine, on 7-11 and 7-18 to Elegant Lady peach, and on 8-16 and 8-23-6 to Ryan Sun peach using an air blast sprayer at 100 gal/A. Fruit were harvested and stored at 1C for 7 days and incubated at 20C for 7 days. There were four single-tree replications for each treatment.

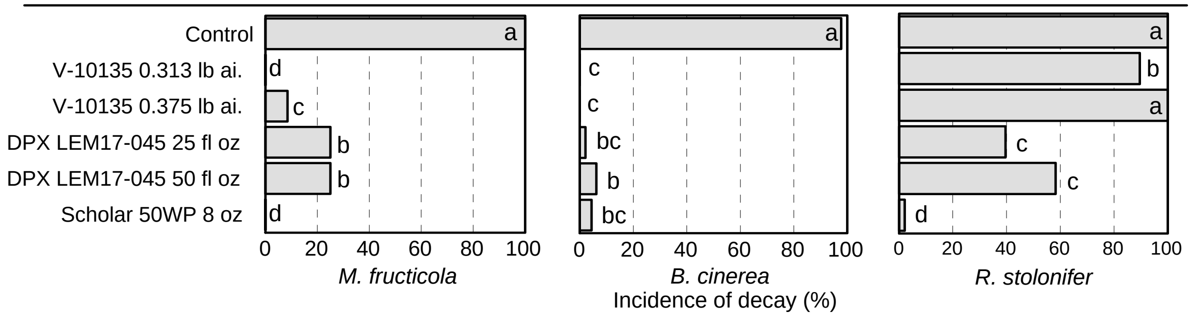
Fig. 3. Efficacy of fungicide treatments applied during dormancy against peach leaf curl of Fay Elberta peaches
- Field trial at UC Davis -

Treatment	12/19/05	1/24/06
Check	---	---
Kocide 2000 - 8 lbs	X	---
Kocide 2000 - 8 lbs	X	X
Nordox 75WG - 3 lbs	X	X
Ziram 76 DF - 8 lbs	X	---
Ziram 76 DF - 8 lbs	X	X
Cuprofix 40DF - 6 lbs	X	X
Ziram + Cuprofix (6/4 lbs)	X	X
Cuprofix 40DF - 6 lbs rotation with Ziram 76 DF - 8 lbs	X ---	--- X



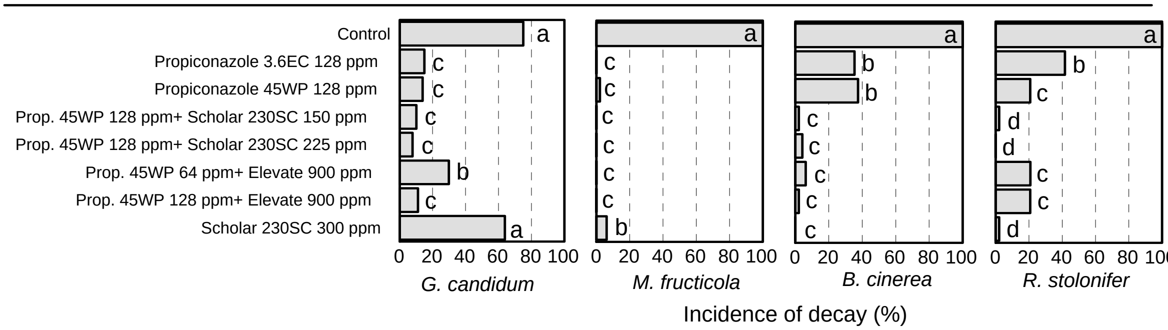
* - Incidence is the average percentage of 100 shoots (4 reps per treatment) with leaf curl when evaluated in April 2006. No oil was included in the applications, however, oil/diazinon was applied in January. Note: copper-oil treatments greatly improve persistence and performance of copper.

Fig. 4. Efficacy of postharvest dip treatments with new fungicides for management of postharvest decays of July Flame peaches
- Fruit inoculated, treated, and incubated -



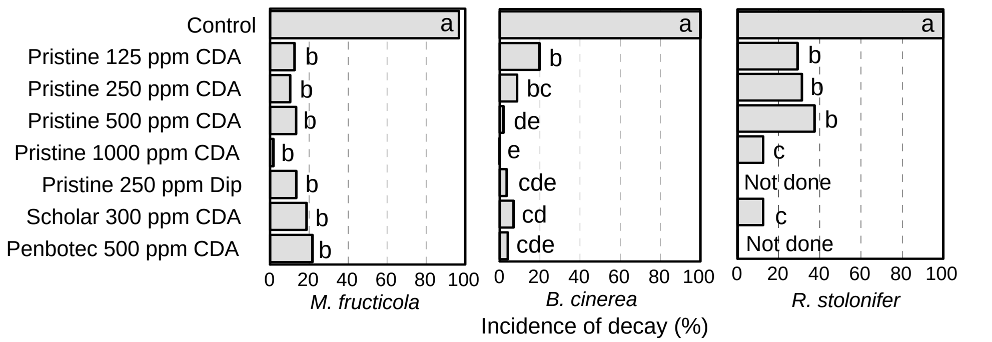
Fruit were wound-inoculated with spores of either decay fungus, incubated for 13-16 h, dipped into aqueous solutions for 30 sec, and incubated for 6 days at 20C.

Fig. 5. Efficacy of postharvest fungicides for management of postharvest decays of Red Diamond nectarines in an experimental packingline study
- Fruit inoculated, treated, and incubated -



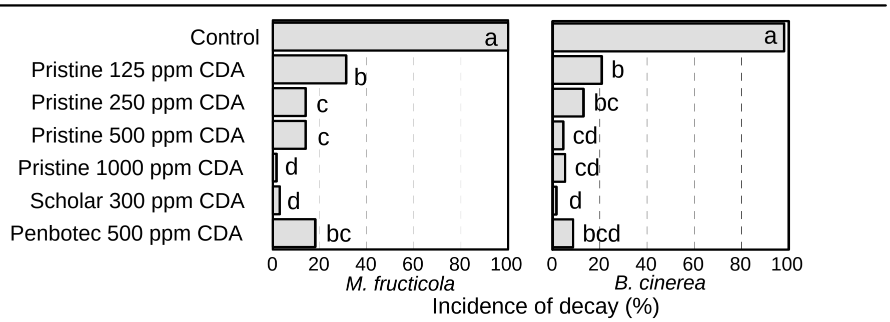
Fruit were wound-inoculated with spores of either decay fungus, incubated for 13-16 h, treated with fungicides using a CDA application system at 25 gal/200,000 lb fruit, and incubated for 6 days at 20C. All treatments were applied in 50% D251.

Fig. 6. Efficacy of postharvest dip treatments with Pristine, Penbotec, and Scholar for management of postharvest decays of Ryan Sun peaches in an experimental packingline study
- Fruit inoculated, treated, and incubated -



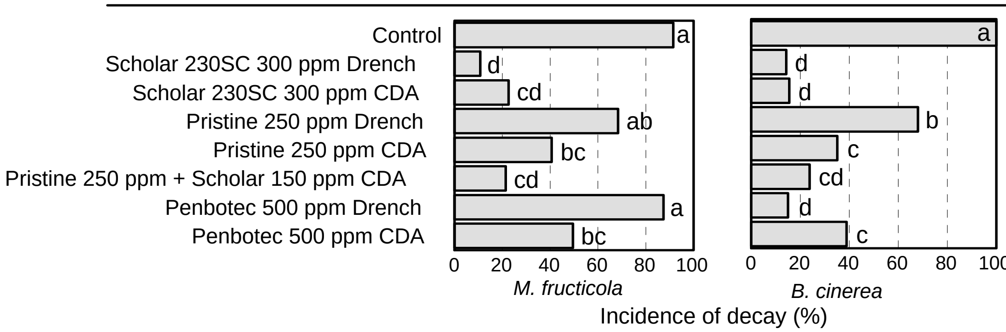
Fruit were wound-inoculated with spores of either decay fungus, incubated for 13-16 h, and treated with fungicides using a CDA application system at 25 gal/200,000 lb fruit or using a 30-sec dip. CDA applications were in 20% D251, dips were in 10% D251. Fruit were incubated for 6 days at 20C.

Fig. 7. Efficacy of postharvest dip treatments with Pristine, Penbotec, and Scholar for management of postharvest decays of Summer Fire nectarines in an experimental packingline study
- Fruit inoculated, treated, and incubated -



Fruit were wound-inoculated with spores of either decay fungus, incubated for 13-16 h, and treated with fungicides using a CDA application system at 25 gal/200,000 lb fruit. Fungicides were in 20% D251. Fruit were incubated for 6 days at 20C.

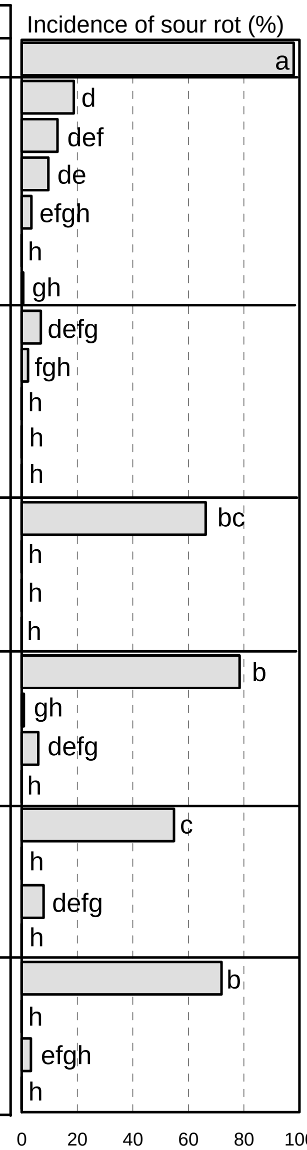
Fig. 8. Postharvest treatments of Casselman plums with Pristine, Penbotec, and Scholar using in-line drench and CDA applications
- Fruit inoculated, treated, and incubated -



Fruit were wound-inoculated with spores of either decay fungus, incubated for 13-16 h at 20C and then for 24 h at 2C, and treated with fungicides using a CDA application system at 25 gal/200,000 lb fruit or an in-line drench system. CDA applications were in 25% Primafresh 45. Fruit were incubated for 6 days at 20C.

Fig. 9. Efficacy of pre- and postharvest fungicide treatments and postharvest washes for management of sour rot of Summer Fire nectarines
- Wounding of drop-inoculated fruit after treatment -

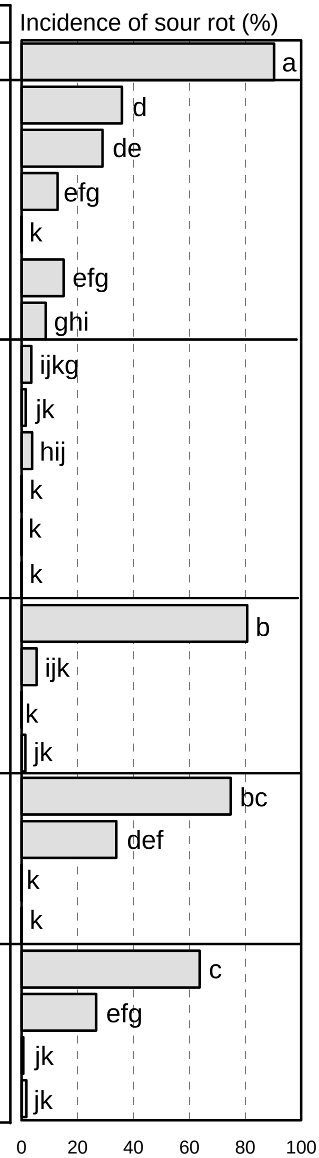
No.	Preharvest	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine 100 ppm 15 sec	---
3	---	Chlorine 100 ppm 30 sec	---
4	---	Chlorine 100 ppm 60 sec	---
5	---	Chlorine+NC 15 sec	---
6	---	Chlorine+NC 30 sec	---
7	---	Chlorine+NC 60 sec	---
8	---	Chlorine+NC 15 sec	64 ppm CDA
9	---	Chlorine+NC 15 sec	128 ppm CDA
10	---	Chlorine+NC 15 sec	128 ppm Drench
11	---	Chlorine+NC 15 sec	128 ppm Drench+chlorine
12	---	Chlorine+NC 15 sec	64 ppm Drench+chlorine
13	Orbit 3.6EC 4 fl oz/100 gal 1 d. PHI	---	---
14	Orbit 3.6EC 4 fl oz/100 gal 1 d. PHI	Chlorine+NC 15 sec	---
15	Orbit 3.6EC 4 fl oz/100 gal 1 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
16	Orbit 3.6EC 4 fl oz/100 gal 1 d. PHI	Chlorine+NC 15 sec	128 ppm Drench
17	Orbit 3.6EC 4 fl oz/400 gal 1 d. PHI	---	---
18	Orbit 3.6EC 4 fl oz/400 gal 1 d. PHI	Chlorine+NC 15 sec	---
19	Orbit 3.6EC 4 fl oz/400 gal 1 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
20	Orbit 3.6EC 4 fl oz/400 gal 1 d. PHI	Chlorine+NC 15 sec	128 ppm Drench
21	Orbit 3.6EC 4 fl oz 7+1 d. PHI	---	---
22	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	---
23	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
24	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	128 ppm Drench
25	Propimax 3.6EC 4 fl oz 7+1 d. PHI	---	---
26	Propimax 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	---
27	Propimax 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
28	Propimax 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC 15 sec	128 ppm Drench



Preharvest applications were made using an air-blast sprayer (100 gal/A, unless indicated otherwise). Fruit were harvested and drop-inoculated with conidia of *G. candidum* ($3x10^5$ conidia/ml). Postharvest washes were done with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or in-line drench applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 10. Efficacy of pre- and postharvest fungicide treatments and postharvest washes for management of sour rot of Summer Fire nectarines
- Wounding of drop-inoculated fruit after treatment -

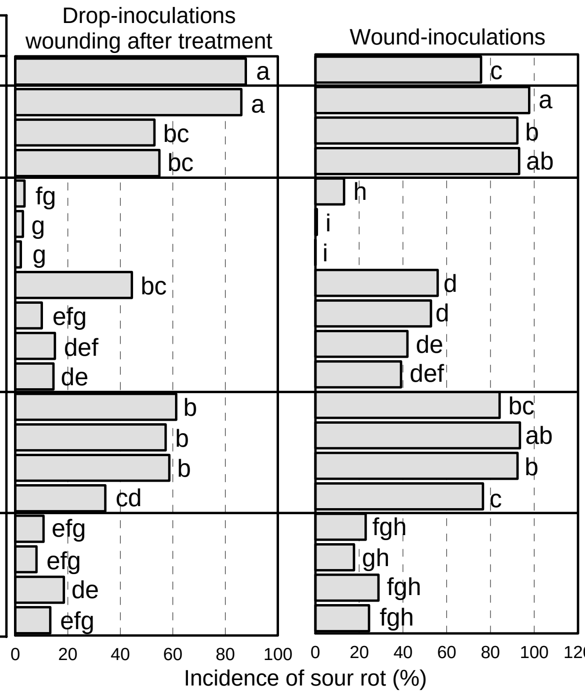
No.	Preharvest	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine 100 ppm 15 sec	---
3	---	Chlorine 100 ppm 30 sec	---
4	---	Chlorine 100 ppm 60 sec	---
5	---	Chlorine+NC 15 sec	---
6	---	Chlorine+NC 30 sec	---
7	---	Chlorine+NC 60 sec	---
8	---	Chlorine+NC 15 sec	64 ppm CDA roller bed
9	---	Chlorine+NC 15 sec	128 ppm CDA roller bed
10	---	Chlorine+NC 15 sec	64 ppm CDA brush bed
11	---	Chlorine+NC 15 sec	128 ppm CDA brush bed
12	---	Chlorine+NC 15 sec	64 ppm Drench
13		Chlorine+NC 15 sec	128 ppm Drench
14	Orbit 3.6EC 4 fl oz 7 d. PHI	---	---
15	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC 15 sec	---
16	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
17	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA bush bed
18	Orbit 3.6EC 4 fl oz 14+7 d. PHI	---	---
19	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	---
20	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
21	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA bush bed
22	GF1798 11 fl oz 14+7 d. PHI	---	---
23	GF1798 11 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	---
24	GF1798 11 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA
25	GF1798 11 fl oz 14+7 d. PHI	Chlorine+NC 15 sec	128 ppm CDA bush bed



Preharvest applications were made using an air-blast sprayer (100 gal/A,). Fruit were harvested and drop-inoculated with conidia of *G. candidum* ($3x10^5$ conidia/ml). Postharvest washes were done with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or in-line drench applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 11. Efficacy of pre- and postharvest fungicide treatments for management of sour rot of Red Diamond nectarines

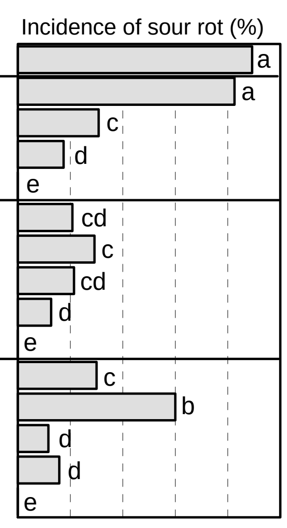
No.	Preharvest 7 day	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Water	---
3	---	Chlorine 100 pm	---
4	---	Chlorine +NC	---
5	---	Water	64 ppm Drench
6	---	Chlorine+NC	64 ppm Drench
7	---	Water	128 ppm Drench
8	---	Water	64 ppm CDA
9	---	Chlorine+NC	64 ppm CDA
10	---	Water	128 ppm CDA
11	---	Chlorine+NC	128 ppm CDA
12	Propimax 4 fl oz	---	---
13	Elite 8 oz	---	---
14	Orbit 2 fl oz+Abound 12.5 fl oz	---	---
15	GF1798 11 fl oz	---	---
16	Propimax 4 fl oz	Water	128 ppm CDA
17	Elite 8 oz	Water	128 ppm CDA
18	Orbit 2 fl oz+Abound 12.5 fl oz	Water	128 ppm CDA
19	GF1798 11 fl oz	Water	128 ppm CDA



Preharvest applications were made using an air-blast sprayer (100 gal/A). Fruit were harvested and inoculated with conidia of *G. candidum* ($3x10^5$ conidia/ml). Postharvest washes were done for 15 sec with water, chlorine at 100 ppm, or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using in-line drench or CDA (25 gal/200 K lb fruit) applications. Drop-inoculated fruit were wounded at the inoculation site after treatment. Fruit were then incubated at 20C for 6 days.

Fig. 12. Efficacy of pre- and postharvest fungicide treatments for management of sour rot of Elegant Lady peaches - Wounding of drop-inoculated fruit after treatment -

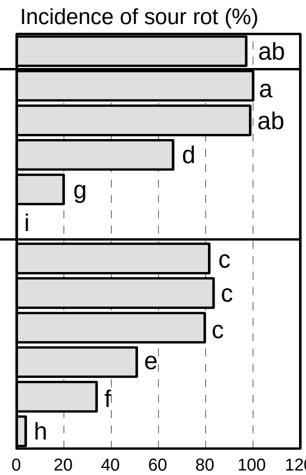
No.	Preharvest 7+1 day PHI	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine+NC	---
3	---	Chlorine+NC	64 ppm CDA
4	---	Chlorine+NC	128 ppm CDA
5	---	---	128 ppm dip
6	Propimax 4 fl oz	---	---
7	Propimax 4 fl oz	Chlorine+NC	---
8	Propimax 4 fl oz	Chlorine+NC	64 ppm CDA
9	Propimax 4 fl oz	Chlorine+NC	128 ppm CDA
10	Propimax 4 fl oz	---	128 ppm dip
11	GF1798 11 fl oz	---	---
12	GF1798 11 fl oz	Chlorine+NC	---
13	GF1798 11 fl oz	Chlorine+NC	64 ppm CDA
14	GF1798 11 fl oz	Chlorine+NC	128 ppm CDA
15	GF1798 11 fl oz	---	128 ppm dip



Preharvest applications were made 7+1 day PHI using an air-blast sprayer (100 gal/A). Fruit were harvested and drop-inoculated with conidia of *G. candidum* ($3x10^5$ conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or 30-sec dip applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 13 Efficacy of pre- and postharvest fungicide treatments for management of sour rot of July Flame peaches
- Wounding of drop-inoculated fruit after treatment -

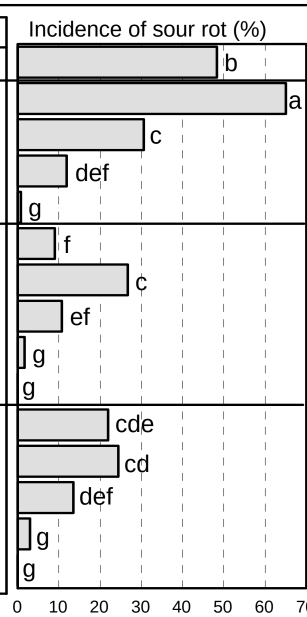
No.	Preharvest 6+1 day PHI	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine 100 ppm	---
3	---	Chlorine+NC	---
4	---	Chlorine+NC	64 ppm CDA
5	---	Chlorine+NC	128 ppm CDA
6		---	128 ppm dip
7	Orbit 3.6EC	---	---
8	Orbit 3.6EC	Chlorine 100 ppm	---
9	Orbit 3.6EC	Chlorine+NC	---
10	Orbit 3.6EC	Chlorine+NC	64 ppm CDA
11	Orbit 3.6EC	Chlorine+NC	128 ppm CDA
12	Orbit 3.6EC	---	128 ppm dip



Preharvest applications were made 6+1 day PHI using an air-blast sprayer (100 gal/A) . Fruit were harvested and drop-inoculated with conidia of *G. candidum* (3x10^5 conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or 30-sec dip applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 14. Efficacy of pre- and postharvest fungicide treatments and postharvest washes for management of sour rot of Ryan Sun peaches
- Treatments of wound-inoculated fruit -

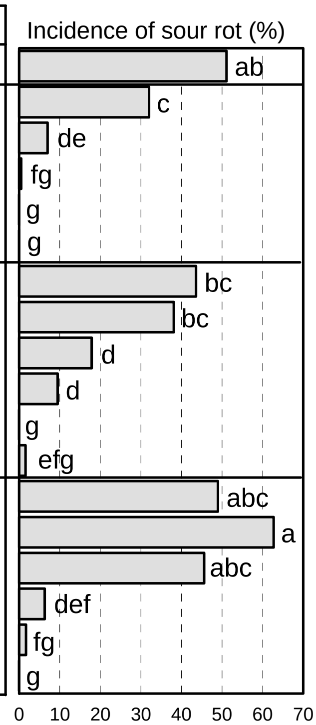
No.	Preharvest	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine 100 ppm	---
3	---	Chlorine+NC	64 ppm CDA brush bed
4	---	Chlorine+NC	128 ppm CDA brush bed
5	---	Chlorine+NC	128 ppm Dip
6	Orbit 3.6EC 4 fl oz 7+1 d. PHI	---	---
7	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine 100 ppm	---
8	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	64 ppm CDA brush bed
9	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	128 ppm CDA brush bed
10	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	128 ppm Dip
11	Orbit 3.6EC 4 fl oz 1 d. PHI	---	---
12	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine 100 ppm	---
13	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	64 ppm CDA brush bed
14	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	128 ppm CDA brush bed
15	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	128 ppm Dip



Preharvest applications were made using an air-blast sprayer (100 gal/A). Fruit were harvested and wound-inoculated with conidia of *G. candidum* (10^6 conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or 30-sec dip applications. After treatment, fruit were incubated at 20C for 6 days.

Fig. 15. Efficacy of pre- and postharvest fungicide treatments and postharvest washes for management of sour rot of Ryan Sun peaches
- Treatments of wound-inoculated fruit -

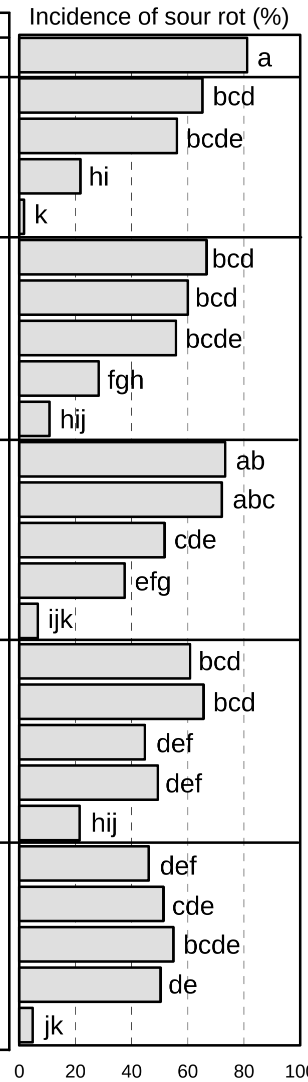
No.	Preharvest	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine+NC	---
3	---	Chlorine+NC	64 ppm CDA brush bed
4	---	Chlorine+NC	128 ppm CDA brush bed
5	---	Chlorine+NC	128 ppm Drench
6	---	Chlorine+NC	128 ppm Dip
7	Orbit 3.6EC 4 fl oz 14+7 d. PHI	---	---
8	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC	---
9	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC	64 ppm CDA brush bed
10	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC	128 ppm CDA brush bed
11	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC	128 ppm Drench
12	Orbit 3.6EC 4 fl oz 14+7 d. PHI	Chlorine+NC	128 ppm Dip
13	Orbit 3.6EC 4 fl oz 14 d. PHI	---	---
14	Orbit 3.6EC 4 fl oz 14 d. PHI	Chlorine+NC	---
15	Orbit 3.6EC 4 fl oz 14 d. PHI	Chlorine+NC	64 ppm CDA brush bed
16	Orbit 3.6EC 4 fl oz 14 d. PHI	Chlorine+NC	128 ppm CDA brush bed
17	Orbit 3.6EC 4 fl oz 14 d. PHI	Chlorine+NC	128 ppm Drench
18	Orbit 3.6EC 4 fl oz 14 d. PHI	Chlorine+NC	128 ppm Dip



Preharvest applications were made using an air-blast sprayer (100 gal/A,). Fruit were harvested and wound-inoculated with conidia of *G. candidum* (10^6 conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit), in-line drench, or 30-sec dip applications. After treatment, fruit were incubated at 20C for 6 days.

Fig. 16. Efficacy of pre- and postharvest fungicide treatments and postharvest washes for management of sour rot of Ryan Sun peaches
- Treatments of wound-inoculated fruit -

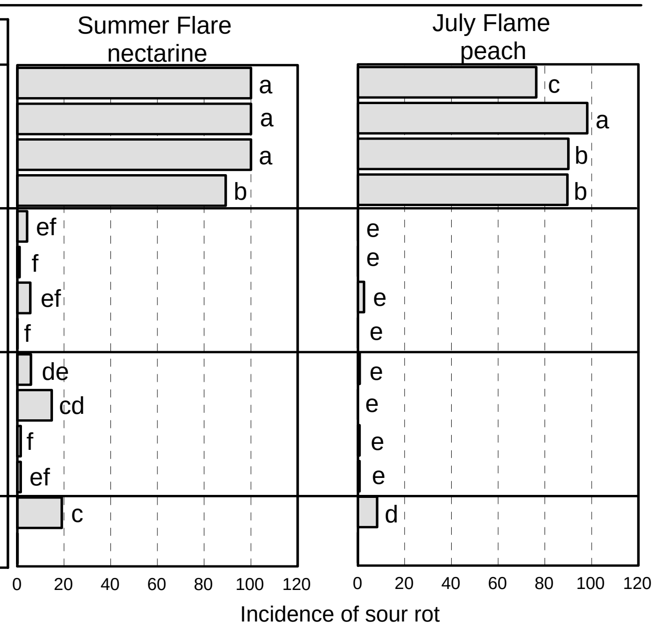
No.	Preharvest	Postharvest wash	Postharvest Orbit
1	Control	---	---
2	---	Chlorine+NC	---
3	---	Chlorine+NC	64 ppm CDA brush bed
4	---	Chlorine+NC	128 ppm CDA brush bed
5	---	Chlorine+NC	128 ppm Drench
6	Orbit 3.6EC 4 fl oz 21+14 d. PHI	---	---
7	Orbit 3.6EC 4 fl oz 21+14 d. PHI	Chlorine+NC	---
8	Orbit 3.6EC 4 fl oz 21+14 d. PHI	Chlorine+NC	64 ppm CDA brush bed
9	Orbit 3.6EC 4 fl oz 21+14 d. PHI	Chlorine+NC	128 ppm CDA brush bed
10	Orbit 3.6EC 4 fl oz 21+14 d. PHI	Chlorine+NC	128 ppm Drench
11	Orbit 3.6EC 4 fl oz 7+1 d. PHI	---	---
12	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	---
13	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	64 ppm CDA brush bed
14	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	128 ppm CDA brush bed
15	Orbit 3.6EC 4 fl oz 7+1 d. PHI	Chlorine+NC	128 ppm Drench
16	Orbit 3.6EC 4 fl oz 7 d. PHI	---	---
17	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC	---
18	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC	64 ppm CDA brush bed
19	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC	128 ppm CDA brush bed
20	Orbit 3.6EC 4 fl oz 7 d. PHI	Chlorine+NC	128 ppm Drench
21	Orbit 3.6EC 4 fl oz 1 d. PHI	---	---
22	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	---
23	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	64 ppm CDA brush bed
24	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	128 ppm CDA brush bed
25	Orbit 3.6EC 4 fl oz 1 d. PHI	Chlorine+NC	128 ppm Drench



Preharvest applications were made using an air-blast sprayer (100 gal/A,). Fruit were harvested and wound-inoculated with conidia of *G. candidum* (10^6 conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using CDA (25 gal/200 K lb fruit) or in-line drench applications. After treatment, fruit were incubated at 20C for 6 days.

Fig. 17. Efficacy of postharvest wash and fungicide treatments for management of sour rot of Summer Flare nectarines and July Flame peaches - Wounding of drop-inoculated fruit after treatment -

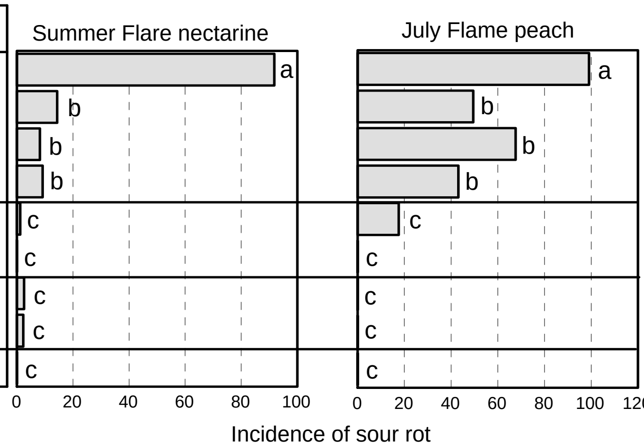
No.	Postharvest wash	Postharvest Orbit
1	---	---
2	Water	---
3	Chlorine 100 pm	---
4	Chlorine +NC	---
5	Chlorine 100 pm	64 ppm Drench
6	Chlorine+NC	64 ppm Drench
7	Chlorine 100 pm	128 ppm Drench
8	Chlorine+NC	128 ppm Drench
9	Chlorine 100 pm	64 ppm CDA
10	Chlorine+NC	64 ppm CDA
11	Chlorine 100 pm	128 ppm CDA
12	Chlorine+NC	128 ppm CDA
13	Chlorine+NC	128 ppm CDA + 1.5 lb Elevate



Fruit were harvested and drop-inoculated with conidia of *G. candidum* (3x10^{5} conidia/ml). Postharvest washes were done with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using in-line drench or CDA (25 gal/200 K lb fruit) applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 18. Efficacy of postharvest wash and fungicide treatments for management of sour rot of Summer Flare nectarines and July Flame peaches - Wounding of drop-inoculated fruit after treatment -

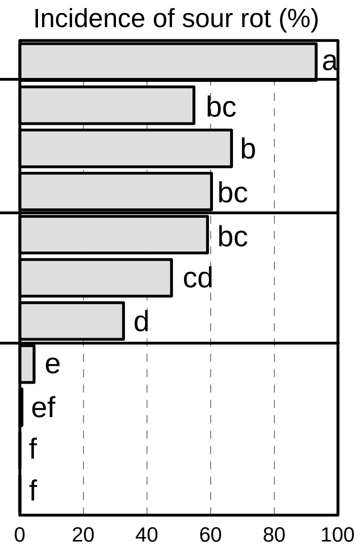
No.	Postharvest wash	Postharvest Orbit
1	Control	---
2	Water	---
3	Chlorine 100 pm	---
4	Chlorine+NC	---
5	Chlorine+NC	64 ppm Drench
6	Chlorine+NC	128 ppm Drench
7	Chlorine+NC	64 ppm CDA
8	Chlorine+NC	128 ppm CDA
9	---	128 ppm Drench



Fruit were harvested and drop-inoculated with conidia of *G. candidum* (2x10^{5} conidia/ml). Postharvest washes were done for 15 sec with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using in-line drench or CDA (25 gal/200 K lb fruit) applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

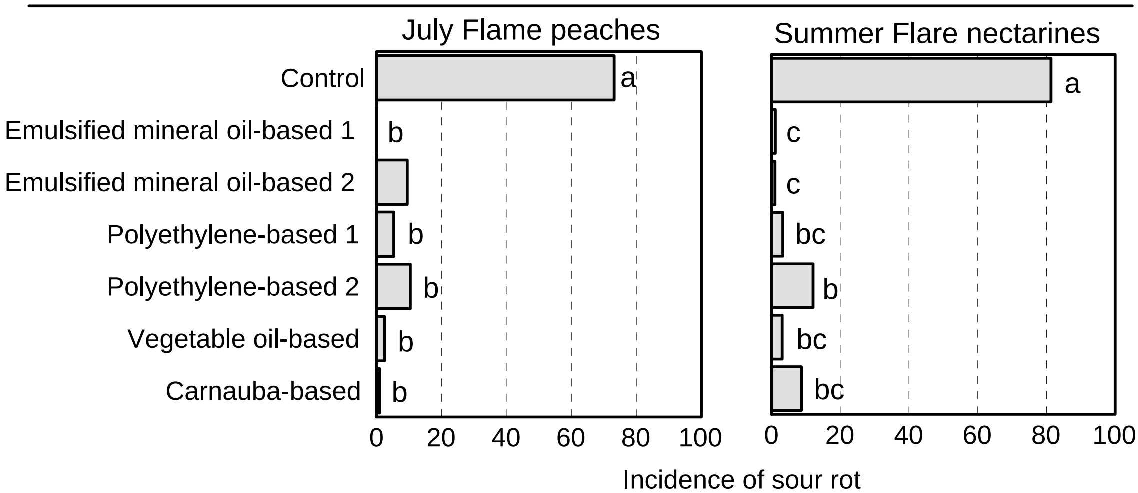
Fig. 19. Efficacy of postharvest wash and fungicide treatments for management of sour rot of Elegant Lady peaches - Wounding of drop-inoculated fruit after treatment -

No.	Postharvest wash	Postharvest Orbit
1	Control	---
2	Chlorine 100 ppm 15 sec	---
3	Chlorine 100 ppm 30 sec	---
4	Chlorine 100 ppm 60 sec	---
5	Chlorine+NC 15 sec	---
6	Chlorine+NC 30 sec	---
7	Chlorine+NC 60 sec	---
8	Chlorine+NC 15 sec	64 ppm CDA brush bed
9	Chlorine+NC 15 sec	128 ppm CDA brush bed
10	Chlorine+NC 15 sec	128 ppm Drench
11	Chlorine+NC 15 sec	64 ppm Drench



Fruit were harvested and drop-inoculated with conidia of *G. candidum* (10^6 conidia/ml). Postharvest washes were done with chlorine at 100 ppm or chlorine and a neutral cleaner (NC). Postharvest fungicide treatments were done using in-line drench or CDA (25 gal/200 K lb fruit) applications. After treatment, fruit were wounded at the inoculation site. Fruit were then incubated at 20C for 6 days.

Fig. 20. Efficacy of treatments with Mentor using different fruit coatings for management of sour rot of July Flame peaches and Summer Flare nectarines - Treatments of wound-inoculated fruit -



Fruit were wound-inoculated with conidia of *G. candidum* (10^6 conidia/ml). Postharvest treatments were done using 30-sec dip applications. After treatment, fruit were incubated at 20C for 6 days.

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