

Annual Report - 2006

Prepared for the California Cling Peach Advisory Board

Title: *Management of Brown Rot and Powdery Mildew Diseases of Peach in California*
Status: Third-Year of Four
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SUMMARY OF RESEARCH ACCOMPLISHMENTS DURING 2006

1. In laboratory studies on the pre- and post-infection activity of fungicides for managing brown rot blossom infections, all fungicides evaluated, including the SBIs Elite, Orbit, and V-10116, as well as Vangard, Scala, V-10135, USF2010, and USF2014 showed very high activity in reducing the incidence of stamen infections.
2. In brown rot blossom blight field studies, all fungicides evaluated including the registered products Pristine, Elevate, 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), and new pre-mixtures (e.g., USF2010 and USF2014) were all highly efficacious and all significantly reduced the incidence of brown rot blossom blight as compared to the control. Vangard and V-10135 were inconsistent in their efficacy and were apparently rate- and/or blossom timing-sensitive. In preharvest fungicide field applications (7+1 days PHI) for brown rot control on naturally infected Fay Elberta, Elegant Lady, and Ryan Sun peaches all fungicides, including Elite, Propimax (and GF1798 - a new formulation of propiconazole), V-10116, Scala, Pristine, V-10135, and new pre-mixtures (e.g., USF2010 and USF2014) significantly reduced the incidence of brown rot decay. 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.
3. In studies evaluating the susceptibility of peach genotypes to brown rot blossom blight, we continued to coordinate our research with Dr. Tom Gradziel. As in most previous years, genotype D62-193 was among the least susceptible genotypes. The commercial cvs. Dr. Davis and White Heath Cling were among the most susceptible ones. As in some previous years, however, the Bolinha variety was more susceptible in these laboratory inoculation studies. Thus, in some years, environmental conditions in the orchard, pre-disposition of the host, and cultural practices may have a more profound effect on blossom susceptibility than the genetic background of the host. With the genetic material currently available, fungicide applications will continue to be critical in the management of blossom blight.
4. 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. Registration of Quintec, Procure, and V-10118 is being pursued. Etiological investigations on the species of mildew found in California were also difficult to continue with a low incidence of disease in most locations.
5. For evaluation of fungicides for management of peach leaf curl, treatments with Ziram, either alone or in a mixture or rotation was more effective in reducing the incidence of peach leaf curl than application with copper materials (no oil). This lack of good efficacy of copper fungicides 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.

INTRODUCTION

In continuing our research on the efficacy of new fungicides, timing of fungicide applications, and development of fungicide rotation programs as a resistance management strategy, in 2006 we conducted field and laboratory studies on the management of brown rot blossom blight and fruit decay, powdery mildew, and

peach leaf curl. Brown rot caused by the fungal pathogens *M. fructicola* and *M. laxa* is the most important disease of stone fruit in California. The blossom blight stage of the disease cycle continues to be critical in the epidemiology of brown rot on stone fruit crops. Primary inoculum consisting of ascospores and conidia from mummified fruit infects blossoms and the diseased blossoms supply secondary inoculum for fruit infections in the current growing season. In management of brown rot blossom blight two areas were emphasized: 1) the efficacy of new fungicides in a short-term strategy; and 2) the evaluation of host susceptibility in F1 progeny resulting from crosses between less susceptible selections (e.g., Bolinha and other genotypes) and California varieties in a long-term strategy. In our research we evaluated natural host resistance in promising new genetic lines of cling peach developed by Dr. Tom Gradziel. Many of these lines have been evaluated for their resistance to fruit brown rot but not for blossom blight resistance. Research on host resistance in the Bolinha genotypes was initiated by myself and the late Dr. Ogawa in the early 1990s. With breeding new selections, host resistance in blossoms needed to be re-evaluated.

The goals for our blossom and preharvest fungicide research is to develop alternative chemistries (e.g., V-10135, pre-mixtures like Pristine and USF2010 or Adamant and 2014, Quintec, V-10118, etc.) to the SBI fungicides for brown rot and powdery mildew management so that preharvest rotation programs can be designed that prevent the overuse of any one class of fungicide. Without the development of new classes of fungicides, the potential of resistant populations to develop to the new single-site mode-of-action fungicides is high. Thus, evaluations of fungicides were continued using registered and new fungicides or formulations.

In 2006 we also conducted several field trials for the evaluation of fungicides against peach leaf curl and powdery mildew. 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.

Objectives

I. Management of brown rot.

- A) Efficacy and timing of representative compounds from each of five new classes of fungicides (e.g., strobilurins, anilinopyrimidines, SBI fungicides (including V-10116 or metconazole), hydroxyanilides, carboxyanilides, and other new classes (e.g., V-10135). Selected mixtures of fungicides will also be evaluated. Pre- and post-infection efficacy will be studied for both blossoms and fruit.
- B) Persistence of anilinopyrimidine residues under high humidity and temperature.
- C) Baseline sensitivities of brown rot fungi to new classes of fungicides.
- D) Natural host resistance of peach to blossom blight and fruit decay

II. Management of peach leaf curl.

- A) Efficacy and timing of ziram and copper treatments.

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

- A) Collection of powdery mildew isolates from peach in California and identification of the causal pathogen(s).
- B) Efficacy of new powdery mildew fungicides (e.g., quinoxyfen or Quintec, triflumizole or Procure, V-10118) and their use in anti-resistance rotation and mixture programs.

MATERIALS AND METHODS

Evaluation of fungicides for management of brown rot blossom blight and preharvest fruit decay.

Laboratory studies were done with Fay Elberta peach blossoms obtained from the UC Davis, Plant Pathology field station. For this, pink bud blossoms were collected, forced open in the laboratory (20C), and either inoculated with a conidial suspension of *M. fructicola* (20K conidia/ml) and then treated with each fungicide using a hand sprayer, or treated and then inoculated (1 day incubation at 20C). Three replications of six blossoms were used for each fungicide. Data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures of SAS 9.1.

A field plot was established at the Kearney Agricultural Center (KAC), Parlier, CA, to evaluate fungicides for control of brown rot blossom blight under natural rainfall conditions. Fungicides were applied

using an air-blast sprayer calibrated to 100 gal/A at 30-40% bloom for Elegant Lady peach and at 20-30% bloom for Ryan Sun peach trees. 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 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. In a second trial on Fay Elberta peach at UCD fungicides were applied 7+1 PHI (8-8 and 8-14-06). Twelve fruit from each of four single-tree replications were harvested and incubated for approximately 7 days at 20 C, >90% RH for development of natural incidence of decay. Data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures of SAS.

Host susceptibility of F1- progeny of Bolinha peach and other selections to brown rot blossom blight. Blossoms of parental Bolinha Q, D62-193, and Dr. Davis accessions, additional California varieties, and selected F1 progeny were collected in the spring of 2006 as suggested by Dr. Gradziel. Blossoms were from trees cultivated in the same orchard or under similar cultural practices. Blossoms were forced open in the laboratory, placed in a container with a layer of wet vermiculite, spray-inoculated with a conidial suspension of *M. fructicola* (10^4 spores/ml) and incubated for 3-4 days at 20 C. The amount of stamen infection was assessed for each of 7 blossoms per each of four replications. Data were submitted to an analysis of variance and least significant difference mean separation procedures were performed using SAS 9.1.

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.

Efficacy of fungicides for management of powdery mildew of cling peach. One trial was established in an orchard in Sutter Co. Single fungicides, pre-mixtures, and rotations were evaluated. Three treatments were applied starting at petal fall. Treatments were: Quintec, Procure, V-10118, Pristine, Orbit, Rally, Evito, Gem, and Quillaja (natural product). Disease was evaluated on 5-18-06 and 6-20-06. For this, 100 fruit of each of the 4 or 5 single-tree replications were evaluated for powdery mildew lesions. Data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures of SAS.

RESULTS AND DISCUSSION

Evaluation of fungicides for management of brown rot blossom blight and preharvest fruit decay. In a laboratory study on Fay Elberta peach, the pre- and post-infection activity (treatments 24 h before or after inoculation) of new fungicides was compared to that of registered ones. In both inoculation-treatment schedules, all fungicides were highly effective in reducing the incidence of stamen infections from that of the control and there was no significant difference between any of the treatments (Fig. 1).

In this year's field trials, the performance of blossom treatments was only evaluated under natural rainfall conditions during bloom. Our new stone fruit orchard at KAC 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 10.6% and 13.8% for non-treated trees of Elegant Lady peach and Ryan Sun peach, respectively (Fig. 2). Most fungicides in these single-application treatments were very effective in reducing the incidence of blossom blight. On both peach 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, Vanguard 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 (Vanguard and Scala), the dicarboximides (Rovral/Oil), and the strobilurin-carboxyanilide mixture (Pristine) are treatments for immediate use in managing brown rot blossom blight. Because iprodione (Rovral) human toxicity was upgraded, re-registration of this fungicide for pre-harvest use is possible and we will support registration on peaches.

The efficacy of preharvest fungicides for control of fruit brown rot decay was evaluated at KAC (8+1 day PHI applications) and UCD (7+1 day PHI applications). At KAC, 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 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 49.1% and 88.5% for Elegant Lady and Ryan Sun, respectively (Fig. 3). On Elegant Lady peach, most treatments were highly effective in reducing the incidence of brown rot. On Elegant Lady peach Propimax in addition to Scala and the Orbit-Abound mixture (rates of 2 fl oz-12.5 fl oz in this mixture) were 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).

In the trial on Fay Elberta peach all fungicides also significantly reduced the incidence of brown rot decay (Fig. 4). Incidence of decay was 34.2% in the control and between 0 (i.e., Pristine, V-10116) and 10.6% (i.e., Scala) for the fungicides. Thus, in both trials at both locations, Pristine and V-10116 were among the best treatments and Scala was less effective, but still significantly reduced the incidence of brown rot as compared to the control.

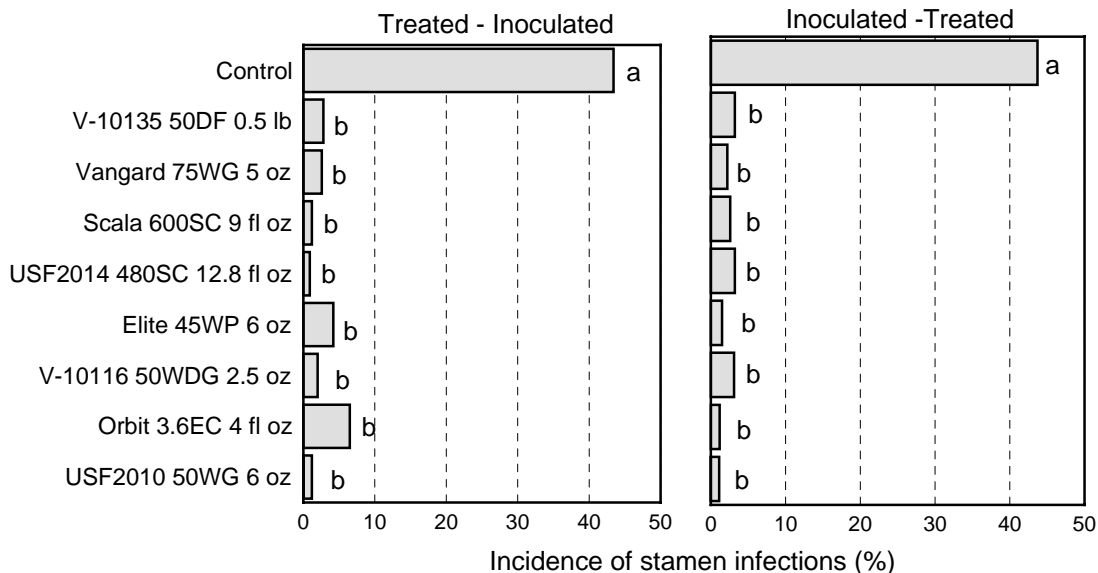
Results on these preharvest fungicide treatments are in agreement with our previous years' data. Thus, selected fungicides are consistent in their performance over the years and on different cultivars, and therefore are reliable preharvest treatments for the stone fruit industry for managing preharvest 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 Vanguard) 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.

Host susceptibility of F1- progeny of Bolinha peach and other selections to brown rot blossom blight. In studies evaluating the susceptibility of peach genotypes to brown rot blossom blight, we continued to coordinate our research with Dr. Tom Gradziel. After laboratory inoculations of freshly opened blossoms, there was a range of susceptibilities present among the genotypes evaluated (Fig. 5). As in most of previous years, genotype D62-193 was among the least susceptible genotypes. The commercial cvs. Dr. Davis and White Heath Cling were among the most susceptible ones. As in some previous years, however, the Bolinha variety was more susceptible in these laboratory inoculation studies. Thus, in some years, environmental conditions in the orchard, pre-disposition of the host, and cultural practices may have a more profound effect on blossom susceptibility than the genetic background of the host. Although some less susceptible peach genotypes have been identified over the years, fungicide applications will continue to be critical in the management of blossom blight.

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. 6). 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.

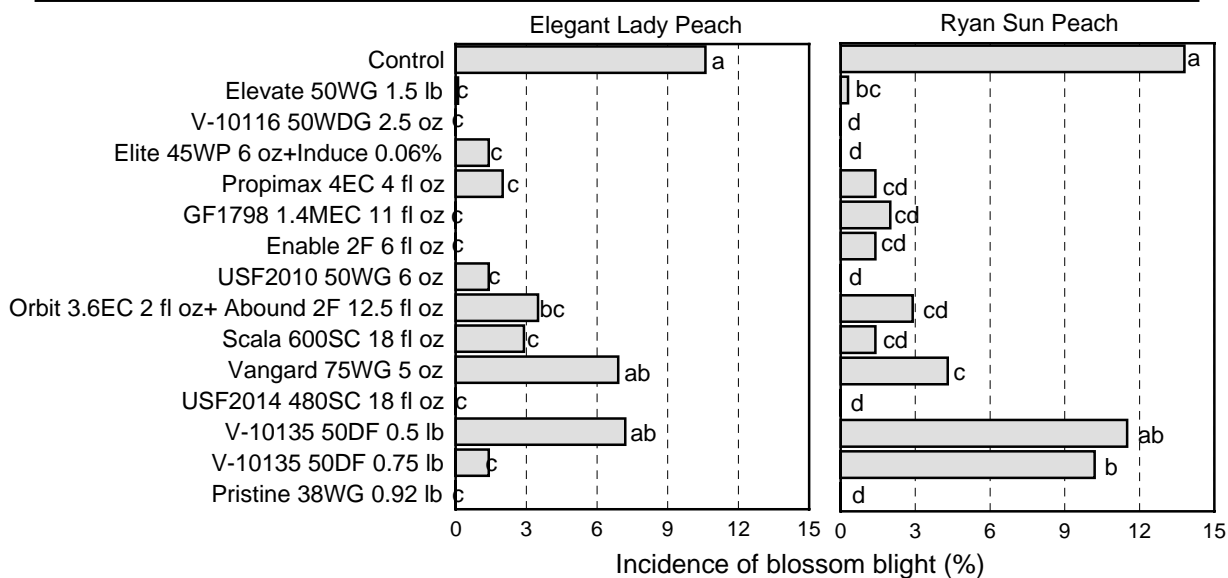
Efficacy of fungicides for management of powdery mildew of cling peach. One trial was established in an orchard in Sutter Co. Single fungicides, pre-mixtures, or rotations were evaluated. Three treatments were applied starting at petal fall and separated by ca. 2 wks prior to pit hardening. Unfortunately, a total of only two diseased fruit were found among the untreated control trees. No disease was found among all treated trees. Thus, no efficacy data could be obtained. Registration of the powdery mildew fungicides Quintec, Procure, and V-10118 that have shown high efficacy in previous trials is being pursued. Etiological investigations on the species of mildew found in California were also difficult to continue in 2006 because of the low incidence of disease in most locations.

Fig. 1. Efficacy of fungicide treatments for management of brown rot blossom blight of Fay Elberta peach in laboratory studies



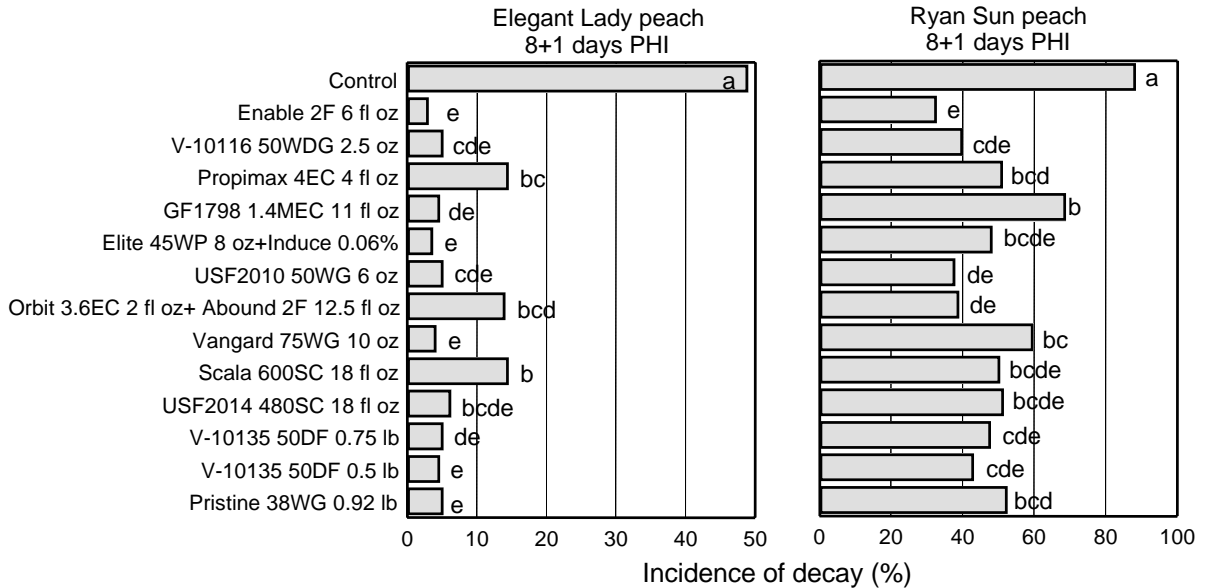
One application of each treatment was made either before or after inoculation and incubation for 24 hr at 20 C. Treatments were applied at the rate indicated per100 gal/A. Blossoms were evaluated for stamen infection on each of six blossoms. There were three replications for each treatment.

Fig. 2. Efficacy of fungicide treatments for management of brown rot blossom blight of two peach cultivars at the Kearney Agricultural Center



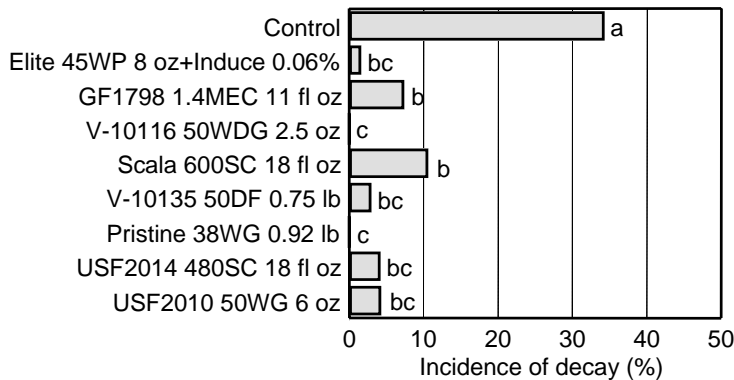
One application of each treatment was made in the field onon 3-1-06 to Elegant Lady (30-40% bloom) and on 3-8-06 to Ryan Sun peach (20-30% bloom) using an air-blast sprayer (100 gal/A) . Blossoms were evaluated for blossom blight on 5-14-06. There were four single-tree replications for each treatment.

Fig. 3. Efficacy of preharvest fungicide treatments for management of fruit brown rot of two peach cultivars at the Kearney Agricultural Center
 - Natural incidence of decay -



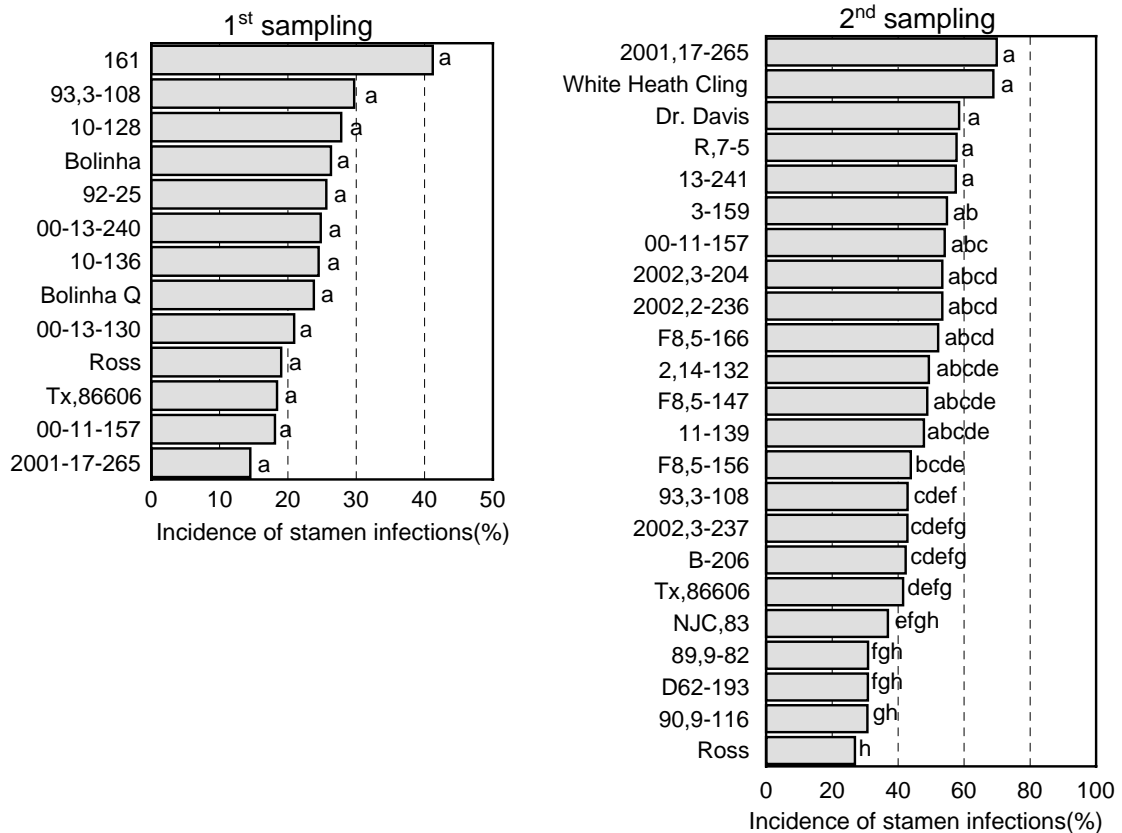
Applications were made in the field using an air-blast sprayer (100 gal/A) on 7-11 and 7-18 to Elegant Lady peach and on 8-16 and 8-23-6 to Ryan Sun peach using an air blast sprayer at 100 gal/A. Fruit were harvested and stored at 1C for 7 days and incubated at 20C for 7 days. There were four single-tree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

Fig. 4. Efficacy of preharvest fungicide treatments for management of fruit brown rot of Fay Elberta peaches at UC Davis
 - Natural incidence of decay -



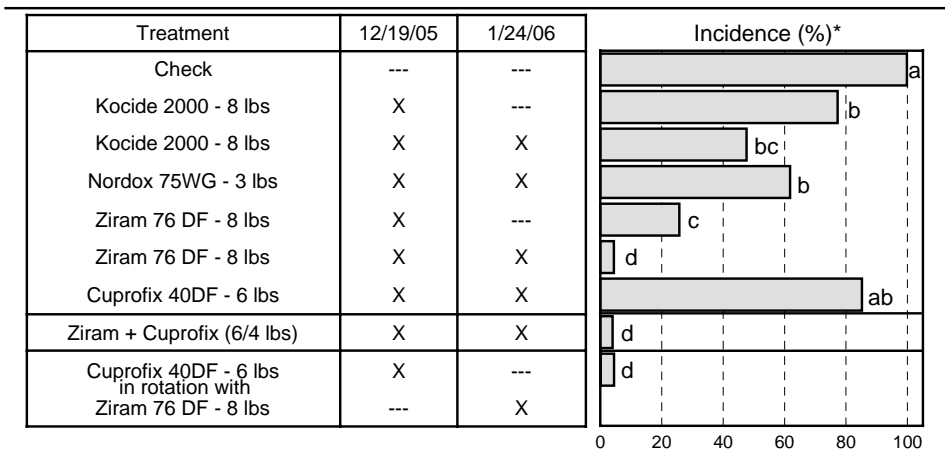
Applications were made in the field using an air-blast sprayer (100 gal/A) on 8-8 and 8-14-06 (7+1 day PHI). Fruit were harvested and incubated at 20C for 7 days. There were four single-tree replications for each treatment.

Fig. 5. Host susceptibility of different peach genotypes and their F1-progeny to brown rot blossom blight



Blossoms at pink bud stage were collected, forced open in the laboratory, and inoculated with conidia of *Monilinia fructicola* (10^4 conidia/ml). Blossoms were evaluated for stamen infection after 3-4 days of incubation at 20C.

Fig. 6. Efficacy of fungicide treatments applied during dormancy against peach leaf curl of Fay Elberta peaches - Field trial at UC Davis -



* - 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.