ENVIROTECH

NOTE TO THE READER:

The following technical report is a collaborative effort of Oregon, Michigan, and Washington State University, the University of California and funded by the California Cherry Advisory Board. It was presented to the general membership annual meeting in December 2007.

The report is a presentation of pre and post-harvest fungicides and wash water sanitation efficacies. If the reader is interested in the efficacy of Enviro Tech's "PERASAN", we would point you to pages 10 and 12. The charts comparing the efficacy of chlorine (bleach) vs. PERASAN are presented on pgs 17 and 18.

The authors have reported the active ingredient in PERASAN (peracetic acid) in terms of hydrogen peroxide. They also refer to the product as "acidified hydrogen peroxide". The active ingredients in PERASAN are 15% peroxyacetic acid and 22% hydrogen peroxide (HP), which is a ratio of 1-1.5 parts by weight, respectively. Thus, if the authors refer to 150 ppm HP, the amount of the peroxyacetic acid would be 100 ppm.

The data results are significant for those who may wish to utilize an organic-approved biocide in their operation, as the PERASAN is approved as organic and the other treatments are not. Considering chlorine bleach in organic production is limited to 4 ppm as total chlorine, the PERASAN would be a valuable alternative.

On one final note, it appears the efficacy of PERASAN in wash water that is NOT washed off with a water rinse appears to be a significant improvement compared to the fruit which had a final water rinse step.

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Annual Report - 2007

Prepared for the California Cherry Advisory Board

Project Title:	Management and Epidemiology of Pre- and Postharvest Foliar and Fruit Diseases of Sweet Cherry
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SUMMARY

In 2007, we conducted blossom, preharvest, and postharvest studies on the major foliar and fruit diseases of sweet cherry in California. In a powdery mildew trial in Lodi (San Joaquin Co.) we continued to demonstrate the excellent activity of the three new powdery mildew materials Procure, Quintec, and V-10118 as compared to the SBI Orbit that also performed very well. Procure (a SBI-imidazole), Orbit (a SBI-triazole), and Quintec (a quinoline) are registered on sweet cherry in California; whereas V-10118 is pending registration through the IR-4 program. In addition, the natural products Quillaja and the Sil-Matrix/Yucca Ag Aide mixture also significantly reduced the incidence of disease, but were not as effective as some of the other treatments. In comparative studies of fungicides applied at full bloom for protection of blossoms, Elite and mixtures of Elite or Orbit with Rovral were the most effective in pre- and post-infection studies on brown rot, whereas the new fungicide V-10135 (representing a new fungicide class) was most effective against gray mold using both treatment-inoculation timings. For fruit brown rot, among the single-fungicides, Elevate, Elite, Procure, and the new SBI V-10116 were the most effective after spray- and wound-inoculations of treated fruit. Elite-Elevate, Orbit-Elevate, and Adament were highly effective among the mixtures and pre-mixtures using both inoculation methods, whereas Pristine was highly effective only when spray-inoculations were done (due to the contact nature of the fungicide). In addition, for some treatments both the 7+0 and 14+7 day PHI applications were equally effective, but for others (i.e., Elevate, Procure) applications closer to harvest were more beneficial. For gray mold, the most effective fungicide was Elevate. Most of the treatments still performed well after fruit were postharvest washed, but efficacy was reduced with Elevate and Polyoxin-D. In laboratory postharvest evaluations, all fungicides evaluated (Scholar, Elite, Mentor (i.e., Orbit), Elevate, Elite-Elevate and Mentor-Elevate mixtures) resulted in excellent control for brown rot decay when fruit were inoculated before or after treatment. These fungicides, except Elite and Mentor, were also highly effective against gray mold. Still, Elite was highly effective when treatments were done 12 h after inoculation. For Rhizopus rot control only Scholar and Elite provided good control. Fruit sanitation treatments with chlorine (100 ppm) or peroxyacetic acid (Perasan; up to 150 ppm hydrogen dioxide) did not control decay of fruit that were wound-inoculated with *M. fructicola* or *B. cinerea* when fruit were washed with water after the 30-sec dip treatments. A significant reduction in Rhizopus decay of fruit occurred with Perasan, but not for chlorine treatments. There was, however, a reduction in decay incidence for brown rot, gray mold, and Rhizopus rot when wound-inoculated fruit were not rinsed with water after treatment. In contrast, a high amount of inoculum on fruit surfaces was killed when non-wounded fruit were drop-inoculated with spores of *M. fructicola*, *B. cinerea*, or *R. stolonifer* before treatments. Overall, both sanitizers (chlorine and Perasan) performed similarly, but Perasan was more effective against *R. stolonifer*. When higher rates of Perasan (up to 600 ppm hydrogen dioxide) were evaluated as spray treatments on wound-inoculated fruit, a significant reduction was found for all three decays, but the efficacy was still lower than for treatments with Elite.

INTRODUCTION

In 2007, we continued to evaluate new fungicides for control of pre- and postharvest diseases of sweet cherry. Because all of the newly registered materials have a single-site mode of action and thus, have a high risk for resistance development, effective rotation materials belonging to different classes are needed to prevent resistance in target pathogens. Materials that were evaluated in 2007 for control of brown rot and gray mold on blossoms and fruit included: V-10135, a new class; V-10116 and Elite, SBI-triazoles; Procure, a SBI-imidazole; Elevate, a hydroxyanilid; polyoxin-D, a biofungicide; pre-mixtures (Pristine, strobilurin + carboxamide; Adament, strobilurin + SBI) and selected fungicide mixtures. For powdery mildew control, we evaluated SBI fungicides (Elite, Rally, Orbit, V-10116, Procure), strobilurins (Gem, Evito), a quinoline (Quintec), the biofungicide polyoxin-D, a new class (V-10118), pre-mixtures (Pristine, Adament), and several natural products (Quillaja, Sil-Matrix + Yucca Ag Aide). Mentor (propiconazole), Scholar, Elite, Judge, and selected mixtures of these fungicides were evaluated in postharvest studies. Thus, our research goal is to have several fungicides belonging to different chemical classes registered to manage specific diseases during bloom, preharvest, and after harvest. In addition, we are also evaluating non-synthetic fungicide alternatives. The development of integrated strategies will be critical for preserving the efficacy of the fungicides and the successful control of diseases of sweet cherry in California in the future.

Preharvest. Brown rot and Botrytis blossom blight, as well as powdery mildew management programs for cherry reduce the incidence of these diseases and reduce preharvest fruit decays by decreasing inoculum levels in the orchard. In a short-season crop such as sweet cherry, it is important to reduce blossom blight to prevent the development of new inoculum that will contaminate and infect healthy fruit during fruit development. Thus, we are evaluating new fungicides, adjuvants, and timing of fungicide applications to provide information that will maximize the efficacy of blossom and preharvest treatments for managing blossom diseases and fruit decays.

Postharvest. Tebuconazole (Elite) that was re-registered in a Section 24C in 2005 is currently the most important postharvest fungicide on sweet cherry in California. Through our research, the fungicides fludioxonil (Scholar) and fenhexamid (Elevate/Judge) were also registered in 2003 and 2005, respectively. Scholar is very effective against the three major decays of sweet cherry (brown rot, gray mold, Rhizopus rot) in contrast to Elite that has a limited efficacy against gray mold and Rhizopus rot unless higher rates are used and to Judge that is only effective against gray mold and brown rot. Elite, however, is more effective against Mucor decays as compared to Scholar and Judge. Because Scholar is very stable in the presence of chlorine, re-circulating drench or flooder treatments with this fungicide can be effectively sanitized, thus, making this treatment more cost-effective.

Other fungicides like Pristine (pyraclostrobin/boscalid) and Penbotec (pyrimethanil), both 'reduced-risk' fungicides, were also extensively evaluated in our program. Pristine has a similar spectrum of activity as Scholar, whereas Judge and Penbotec are not effective against Rhizopus rot. Still, Pristine may not be developed for postharvest use based on the world-wide marketing goals of BASF. Penbotec is expected to be registered in 2009. In 2006 and 2007, Mentor (propiconazole) was granted emergency registrations on peaches and nectarines for postharvest sour rot control. Because this fungicide is also very effective against brown rot and may have some activity against gray mold and Rhizopus rot, the registrant indicated the support of a postharvest registration on sweet cherry. Therefore, we evaluated Mentor in 2007. In addition to postharvest fungicides, new sanitation treatments to disinfest fruit and water during postharvest handling are another focus of our research.

Objectives

1. Evaluate, under field conditions, bloom and preharvest applications of new experimental compounds (e.g., fungicides such as V-10135 and biological products) as compared to registered fungicides for control of brown rot blossom blight and pre- and postharvest brown rot fruit decay.
   a. Continue to identify new treatments for gray mold (a weakness of DMI fungicides) and brown rot (to prevent resistance from developing to DMI fungicides in orchard populations of *Monilinia* species with potential overuse of these fungicides)

   b. Evaluate new powdery mildew fungicides (i.e., V-10118) and develop a powdery mildew fungicide program that integrates newly registered materials with current single-site and multi-site mildew fungicides.
2. Determine the efficacy of new fungicides as postharvest treatments and develop cost-effective application methods:
   a. Continue to evaluate Elite-Elevate mixtures, Pristine, and Penbotec (pyrimethanil) as compared to Scholar and evaluate new fungicides (i.e. V-10135).
   b. Cooperate with IR-4 representatives in conducting GLP residue studies with propiconazole (Mentor).
   c. Continue to develop EC_{50} values, baseline sensitivities, and resistance monitoring in target pathogen populations to newly developed fungicides.
3. Evaluate postharvest sanitation treatments, including ozone and peroxyacetic acid and compare to standard sodium hypochlorite treatments.

MATERIALS AND METHODS

Evaluation of new fungicides for control of powdery mildew of sweet cherry. A field trial in San Joaquin Co. was established to evaluate fungicides for powdery mildew control. Applications of fungicides were done on April 4 (petal fall) and April 18 using an air-blast sprayer at 100 gal/A. For disease evaluation on June 1, 2007, 4 shoots from inside the tree for each of the four single-tree replications were rated for disease based on a scale of 0 = healthy, 1 = 1-2 lesions/leaf, 2 = 3-8 lesions/leaf, and 3 = 9-25 lesions/leaf, 4 = >25 lesions/leaf. Data were analyzed using analysis of variance and LSD mean separation procedures of SAS 9.1.

Evaluation of new fungicides for control of brown rot and Botrytis blossom blight and fruit decay. To evaluate the pre-infection activity of fungicides, blossoms were collected on 3-21-07 and treated in the laboratory using a hand sprayer. After 12 h, blossoms were inoculated with a spore suspension of *M. fructicola* or *B. cinerea* (10,000 conidia/ml) until water droplets formed on anther filaments. To evaluate the post-infection activity, blossoms were collected, inoculated, and after 24 h treated with a hand-sprayer. Blossoms were evaluated for stamen infection after 4-5 days of incubation at 20 C, >95% relative humidity. Disease incidence was evaluated as the number of stamens infected divided by the total number of anthers per blossom. Three replications of 7 blossoms were used for each treatment and data were analyzed using analysis of variance and LSD mean separation procedures of SAS 9.1.

To evaluate preharvest fungicides for control of fruit decay, two orchard sites were established. Fungicides were applied to trees in the field using a back-pack sprayer calibrated to deliver 100 gal/A at 7+0 and 14+7 days PHI in a plot in San Joaquin Co. and at 7+1 and 14+7 days PHI in a plot at UC Davis. For wound-inoculations, 7 fruit from each of four single-tree replications were wounded with a glass rod (1 x 1 x 0.5 mm), inoculated with 20 µl of a conidial suspension of *M. fructicola* or *B. cinerea* (30,000 conidia/ml), and incubated for 3-7 days at 20 C, >95% RH. Additional spray inoculations were conducted for brown rot. For this, 80-100 fruit from each replication were sprayed with conidia of *M. fructicola* (10,000 conidia/ml). Percent incidence of infection for brown rot and gray mold was determined as the number of fruit infected of the total number of fruit evaluated. Data were analyzed as described above.

Evaluation of preharvest treatments for postharvest decay control. To evaluate preharvest fruit treatments for postharvest decay management, treatments were applied 7+0 and 14+7 days before harvest. After harvest, fruit were washed for seven minutes in a commercial hydrocooler or not washed, wound-inoculated as described above using spore suspensions of *M. fructicola* or *B. cinerea* (20 µl of 30,000 conidia/ml), and incubated at 20C for 5-7 days. Data were based on seven fruit for each of four single-tree replications for each treatment. Fruit (80-100 fruit/replication) were also spray-inoculated with *M. fructicola* and incubated as described above. Data were analyzed as described above.

Efficacy of new postharvest treatments for control of brown rot, gray mold, and Rhizopus rot of sweet cherry. In comparative laboratory tests, the efficacy of different rates Mentor was compared to that of Elite, Scholar, Judge, and mixtures of Judge and Elite or of Judge and Mentor. Fungicides were either applied as aqueous suspensions or in a diluted fruit coating (i.e., 5% D255). Fruit were inoculated, incubated for 12 h, and then treated. For wound-inoculation, 7 fruit for each replication were wounded with a glass rod (1 x 1 x 0.5 mm) and inoculated with 20 µl of a spore suspension of *M. fructicola, B. cinerea,* or *R. stolonifer* (30,000 spores/ml). Fruit were incubated for 4-7 days at 20 C, >95% RH. Incidence of decay was determined as the number of fruit infected of the total fruit evaluated. Data were analyzed using analysis of variance procedures of SAS 9.1.

Evaluation of penetration of selected fungicides into cherry fruit tissue. A fruit assay that was developed previously was used to determine and characterize the systemic action of selected fungicides on sweet cherry. In these studies fruit were treated with Mentor or Elite as aqueous solutions or in a diluted fruit coating (5% D255) using an air-nozzle sprayer, air-dried, stored overnight at 20 C, and then inoculated with 5 µl spore suspension of *M. fructicola* (150,000 spores/ml) at the pit using a syringe on the lateral side of the fruit opposite the suture and perpendicular to the surface of the fruit. After 3-4 days, fruit were cut in half through the inoculation wound from the blossom to stem end and the decay-free zone from fruit epicarp to the pit was measured. Treatments consisted of three replications using seven fruit per replication. Data were analyzed using analysis of variance and LSD mean separation procedures of SAS 8.2.

Evaluation of acidified hydrogen peroxide as a new fruit sanitation treatment. In laboratory studies to evaluate the activity of acidified hydrogen peroxide (provided as the product Perasan), wounded or non-wounded fruit were drop-inoculated with *M. fructicola, B. cinerea,* or *R. stolonifer* (30,000 spores/ml). After incubation for 12 h at 20C, fruit were dipped into sanitizing solutions (100 or 150 ppm Perasan, based on the concentration of hydrogen peroxide; or 100 ppm chlorine) for 30 sec and then rinsed or not rinsed with water. Drop-inoculated fruit were then wounded using sterile toothpicks. All fruit were incubated at 20C. In another study, wound-inoculated fruit were spray-treated with Perasan (150, 300, or 600 ppm hydrogen peroxide) or Elite after 9 h, and then incubated. Data on incidence of decay were analyzed using analysis of variance and LSD mean separation procedures of SAS 9.1.

RESULTS AND DISCUSSION

Evaluation of new fungicides for control of powdery mildew of sweet cherry. Powdery mildew incidence and severity on sweet cherry were low again in the spring of 2007. In our research plot, an average of 3.2 lesions/leaf had developed at the time of evaluation in early June on untreated control trees. All fungicides evaluated, including powdery mildew-specific (i.e., the registered Quintec and the experimental V-10118) and non-specific materials, significantly reduced the severity of powdery mildew as compared to the control (Fig. 1). The best treatments included the three new powdery mildew materials Procure, Quintec, and V-10118. These latter treatments performed similarly well as Orbit, Rally, the pre-mixture Pristine, and the new pre-mixture Adament. These results indicate that several highly effective fungicides are currently available for management of powdery mildew of sweet cherry. Procure (a SBI-imidazole), Orbit (a SBI-triazole), and Quintec (a quinoline) are registered on sweet cherry in California, whereas V-10118 is pending registration through the IR-4 program. These fungicides belong to several chemical classes and thus, resistance management strategies using rotation programs can be designed. As petal fall treatments in these programs, materials should be used that are also very effective against blossom blight such as Orbit and Pristine, whereas for the following treatment(s) powdery mildew-specific fungicides could be used. In our trial, the natural products Quillaja and the Sil-Matrix/Yucca Ag Aide mixture also significantly reduced the incidence of disease, but were not as effective as some of the other treatments. We evaluated Quillaja previously, and although its performance has been somewhat variable in our trials, it could be a valuable tool in situations where fungicide use has to be minimized or eliminated for specific markets.

Efficacy of new fungicides for control of brown rot and Botrytis blossom blight. In comparative studies of fungicides applied at full bloom for protection of blossoms, all fungicides evaluated significantly reduced brown rot blossom blight when blossoms were inoculated with *M. fructicola* or *B. cinerea* 12 h after treatment and there was no significant difference among the treatments (Fig. 2A,B). In studies on the post-infection activity (blossoms treated 1 day after inoculation) of the fungicides, all materials were very effective against brown rot (Fig. 2A), whereas for Botrytis blossom blight the experimental V-10135 was the most effective material followed by Rovral (Fig. 2B). Overall, numerically, Elite and mixtures of Elite or Orbit with Rovral were the most effective in pre- and post-infection studies on brown rot, whereas the new fungicide V-10135 was most effective against gray mold using both treatment-inoculation timings. Because this fungicide belongs to a new class, it could be a valuable component in mixture and rotation programs if registration is being pursued. Based on these data, the premix fungicide Pristine (boscalid+pyraclostrobin), as well as mixtures of an SBI fungicide (e.g., Elite, Orbit, Rally, Indar) with Elevate (previous years' data) or Rovral are the best choices among currently registered fungicides for blossom blight control when both pathogens have to be controlled. Because all fungicides had good pre- and post-infection activity, the practice of a single delayed-bloom spray when environmental conditions are not very conducive for disease development is being validated on sweet cherry.

Evaluation of preharvest treatments for fruit decay control. Two preharvest efficacy trials were conduced again in 2007. Spray-inoculations with *M. fructicola* (brown rot) of non-wounded fruit in the first trial in San Joaquin Co. indicated a very high efficacy of all fungicides evaluated when applied 7+0 or 14+7 days before harvest (Fig. 3A). In wound-inoculation studies, Elevate, Elite, Procure, and V-10116 were highly effective against brown rot among the single-fungicides (Fig. 4A). Elite-Elevate, Orbit-Elevate, and Adament performed very well among the mixtures and pre-mixtures at both timings. For gray mold, Elevate was the most effective fungicide, but V-10135, Polyoxin-D, and the three mixtures (Elite-Elevate, Orbit-Elevate, Polyoxin D-Elevate) also significantly reduced the incidence of decay (Fig. 4B). Although not consistent, there was a trend that the SC formulation of V-10135 was more effective than the DW formulation.

In wound-inoculation studies in the UC Davis trial, all fungicides, except Pristine, were highly effective against brown rot (Fig. 5A), whereas again Elevate, V-10135 (at both rates), and the mixture programs were very effective against gray mold at both timings (Fig. 5B). Thus, some fungicides performed very well in spray- and wound-inoculations of fruit (i.e., Elevate, Elite, Procure, and the new SBI V-10116), whereas others such as Pristine, V-10135, and Polyoxin-D did not penetrate the fruit and are mainly wound-protection treatments. In addition, for some treatments both the 7+0 and 14+7 day PHI applications were equally effective, but for others (i.e., Elevate, Procure, Polyoxin-D) applications closer to harvest were more beneficial.

Evaluation of preharvest treatments for postharvest decay control (Effectiveness of field treatments after postharvest hydrocooler washes). When preharvest-treated fruit were washed in a commercial hydrocooler before inoculation, most of the treatments still performed well, however, efficacy was reduced in some treatments such as Polyoxin-D in both 7+0 and 14+7 day PHI treatments, as well as V-10135, Pristine, and Polyoxin-D/Elevate in the 14+7 day PHI treatments (Fig. 3). In wound-inoculation studies, treatments were more effective on non-washed fruit than on washed fruit (Fig. 4). Still treatments with Polyoxin-D, V-10135, or Pristine performed poorly in these studies because they are contact materials (non-systemic) and the wounding apparently by-passed the protective fungicide layer on the fruit surface. As in previous years, the SBI fungicides (e.g., Elite, Procure, Orbit, V-10116) and mixtures of an SBI with Elevate or with a strobilurin (e.g., Adament) were very effective in postharvest brown rot control after fruit washing, but the efficacy was sometimes reduced in the 14+7 day PHI treatments. For gray mold, except for V-10135, treatments that were effective on non-washed fruit were less effective on the washed fruit. V-10135 and Elevate reduced both brown rot and gray mold on the washed fruit and generally the SC formulation of V-10135 was more effective than the DW formulation.

Efficacy of new postharvest treatments for control of brown rot, gray mold, and Rhizopus rot of sweet cherry. A comparative evaluation of new and registered fungicides was done in laboratory studies where fruit were wound-inoculated and then treated, all fungicides evaluated (Elite, Judge, Mentor, Elite-Judge and Mentor-Judge mixtures) resulted in no brown rot decay (Fig. 6). Mentor was the only fungicide with poor efficacy against gray mold. Elite at the 8-oz rate worked very well as an aqueous treatment, but efficacy against gray mold was reduced as a treatment in a fruit coating. For Rhizopus rot control, only Scholar and Elite were very effective in both aqueous and fruit coating treatments. When Elite, however, was mixed with Judge, Rhizopus rot was not controlled. Similarly, Rhizopus control using Mentor was intermediate but mixtures of Mentor with Judge had no effect on the decay. Thus, this indicates a negative interference between SBI fungicides and the hydroxyanilid Judge. To find out if higher rates of Mentor would be more effective against gray mold and Rhizopus rot, a rate study was conducted with this fungicide. As shown in Fig. 7, even at the 8-oz rate, Mentor was not very efficacious against the two decays, in contrast to Elite treatments at 8 oz that reduced gray mold to zero levels and resulted in a over 70% reduction of Rhizopus rot as compared to the untreated control.

Evaluation of penetration of selected fungicides into cherry fruit tissue. A pit inoculation assay using treated fruit was used to evaluate the penetration of fungicides into fruit tissue. After 6 days of incubation at 20C, non-treated control fruit inoculated with *M. fructicola* were decayed all the way from the pit to the fruit surface. As indicated by the depth of the decay-free outer zone of the fruit, penetration of Elite and Mentor was similar and there was no difference in using the fungicides as aqueous solutions or in a diluted fruit coating (e.g., D255). These results indicate that the differences in efficacy for the two SBI fungicides as described above (e.g., Figs. 6, 7) are not due to different uptake by the host tissue, but by the spectrum of activity of the active ingredients themselves.

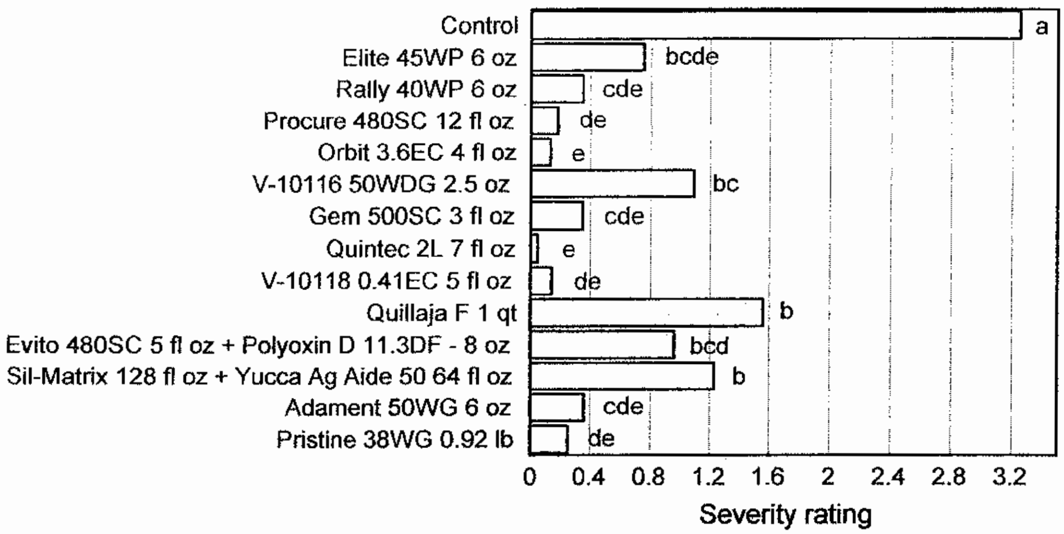
Currently, three postharvest fungicides (Elite, Scholar, and Judge) are registered on sweet cherry, and hopefully others (e.g., Pristine, Penbotec, Mentor) will follow in the near future. All these fungicides belong to different classes and all, except Elite and Mentor, are 'reduced-risk' fungicides. Pristine has a similar spectrum of activity as Scholar. Judge and Penbotec are not active against Rhizopus decay. For management of decays caused by species of *Mucor,* Elite is the most effective material; Scholar, Judge, and Penbotec are not effective, whereas Pristine previously was shown to have some activity against decay caused by *M. piriformis*. This year's data indicate that Mentor has a very narrow-spectrum of activity on sweet cherry. This fungicide will be registered on peaches and nectarines especially for sour rot control but it also has very good activity against brown rot. Thus, this fungicide will not be very useful as a stand-alone treatment, but may be a good mixture partner with another material on sweet cherry for control of gray mold and Rhizopus rot.

Evaluation of acidified hydrogen peroxide as a new fruit sanitation treatment. In fruit sanitation treatments, the efficacy of dip treatments with peroxyacetic acid (Perasan; up to 150 ppm hydrogen peroxide) was compared to that of chlorine (100 ppm). Wounded and non-wounded fruit were drop-inoculated and after treatment, fruit were rinsed or not rinsed with water. Non-wound-inoculated fruit were wounded after treatment and the development of decay was used as an indication of the degree of sanitation of the fruit surface. When wound-inoculated fruit were not rinsed with water after treatment, a significant reduction in decay incidence for brown rot, gray mold, and Rhizopus rot was found for Perasan, but not for chlorine (Fig. 9A). The higher rate of Perasan (150 ppm hydrogen peroxide) was numerically, but not significantly, more effective than the lower rate (100 ppm). When non-wounded fruit were drop-inoculated, treated, and then wounded, dip treatments with both chlorine and Perasan were highly effective (Fig. 9B). Dip treatments with water alone, however, also significantly reduced the incidence of decay, indicating that a large amount of inoculum was removed from the fruit surface by the water dip.

When fruit were rinsed after the sanitation dip treatments, both sanitizers (and the water treatment) again significantly reduced the incidence of the three decays when non-wounded fruit were inoculated before treatment. (Fig.10B). Treatments of wounded, inoculated fruit, however, were ineffective for brown rot and gray mold. For Rhizopus rot only Perasan significantly reduced the incidence of decay and the higher rate of 150 ppm was more effective (Fig. 10B). Thus, water rinses after the sanitizer treatments reduced their efficacy in controlling decay of wounded, inoculated fruit. Apparently, the longer exposure times on non-rinsed fruit kill more of the pathogen that resides in the fruit wounds.

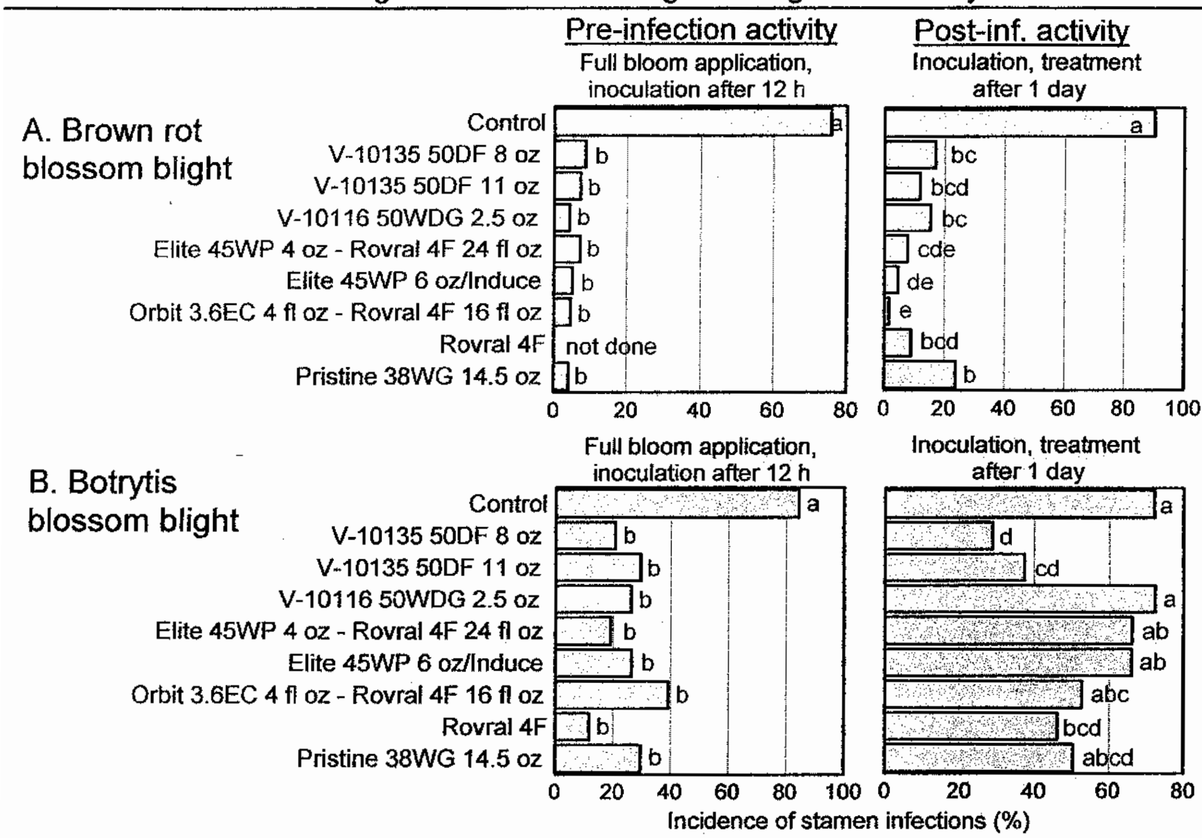
When higher rates of Perasan (up to 600 ppm hydrogen dioxide) were evaluated as spray treatments on wound-inoculated fruit, a significant reduction was found for all three decays, but the efficacy was still lower than for treatments with Elite (Fig. 11). In addition, phytotoxicity was observed after treatments with the high rate of Perasan that was evident as minor necrotic pitting. In summary, long exposures of dilute treatments without post-treatment water rinses may be one way to utilize this material (Fig. 9A,B). This maybe achieved with treatments immediately before packing. Thus, additional studies are warranted.

Fig. 1. Efficacy of preharvest fungicide applications for management of powdery mildew of Bing sweet cherries in San Joaquin Co. - 2007



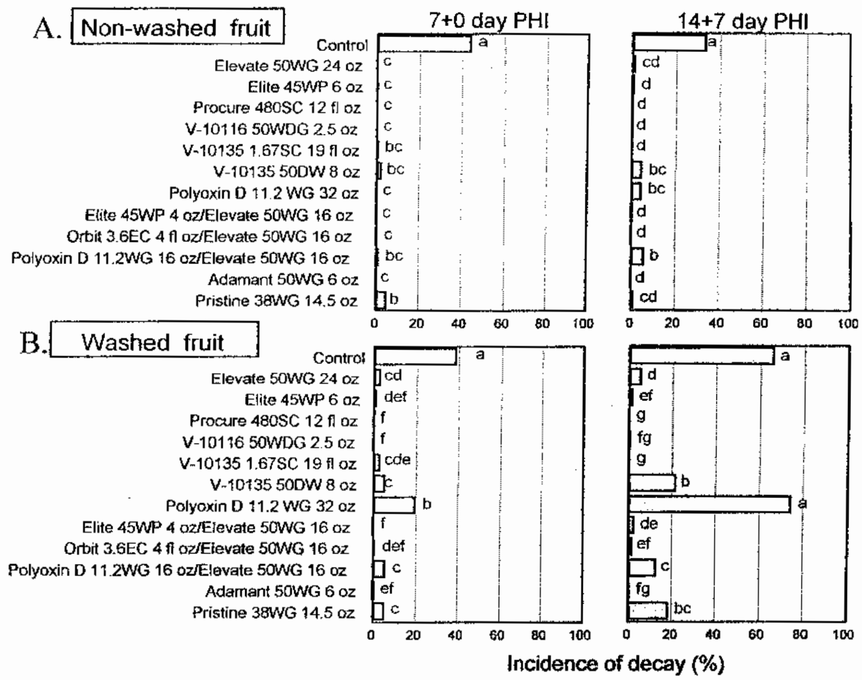
Treatments were applied in the field using an air-blast sprayer (100 gals/A) on 4-4 and 4-18-07. Evaluation was done on 6-1-07. For this, 4 shoots from inside the tree were rated for disease based on a scale of 0 = healthy, 1 = 1-2 lesions/leaf, 2 = 3-8 lesions/leaf, and 3 = 9-25 lesions/leaf, 4 = >25 lesions/leaf.

Fig. 2. Efficacy of pre- and post-infection treatments with selected fungicides for management of blossom blight of Bing sweet cherry



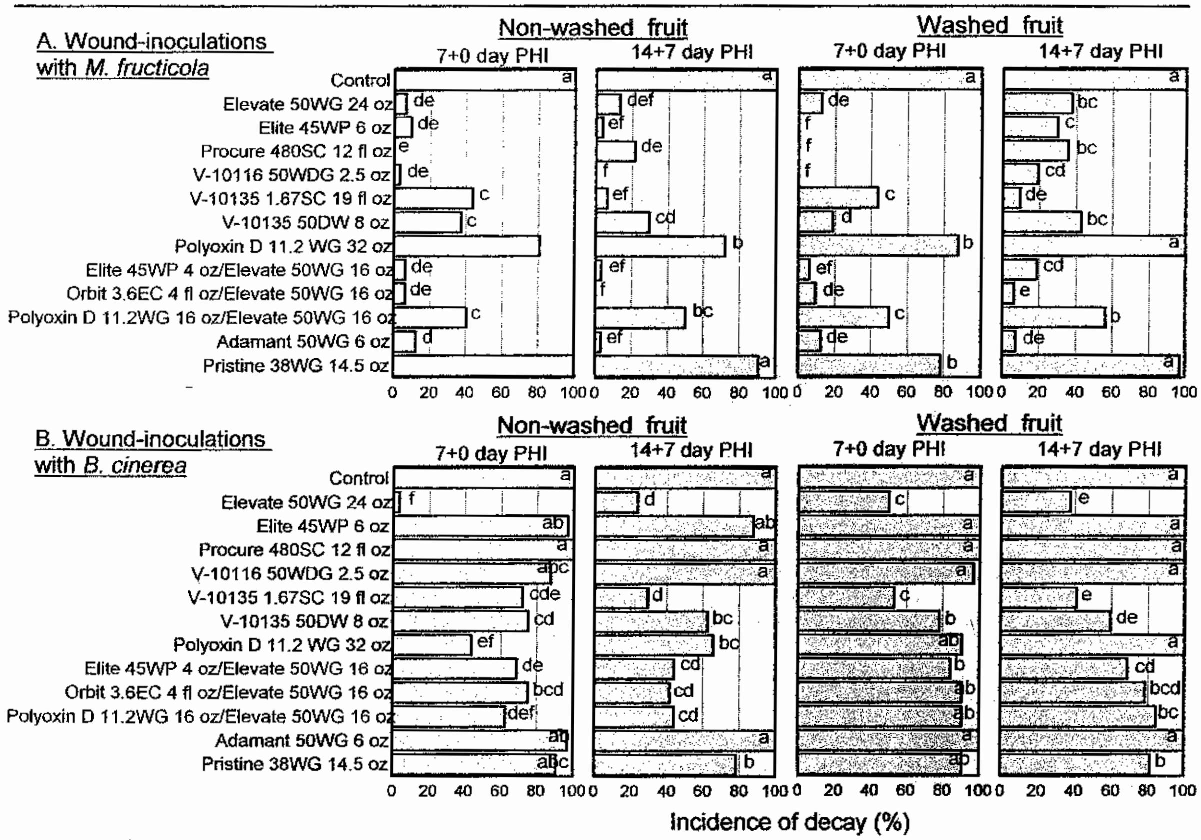
For evaluation of the pre-infection acticity, blossoms were collected in the field and treated in the laboratory using a hand sprayer. After 12 h blossoms were inoculated with a spore suspension of *M. fructicola* or *B. cinerea* (10K/ml). For evaluation of the post-infection activity, blossoms were collected and inoculated and were treated with a hand-sprayer after 24 h. Blossoms were evaluated for stamen infections after 3-4 days of incubation at 20 C.

Fig. 3. Efficacy of 7+0 and 14+7 day preharvest fungicide treatments for management of postharvest decays of Bing cherries
Spray-inoculations of non-wounded treated fruit with *M. fructicola*



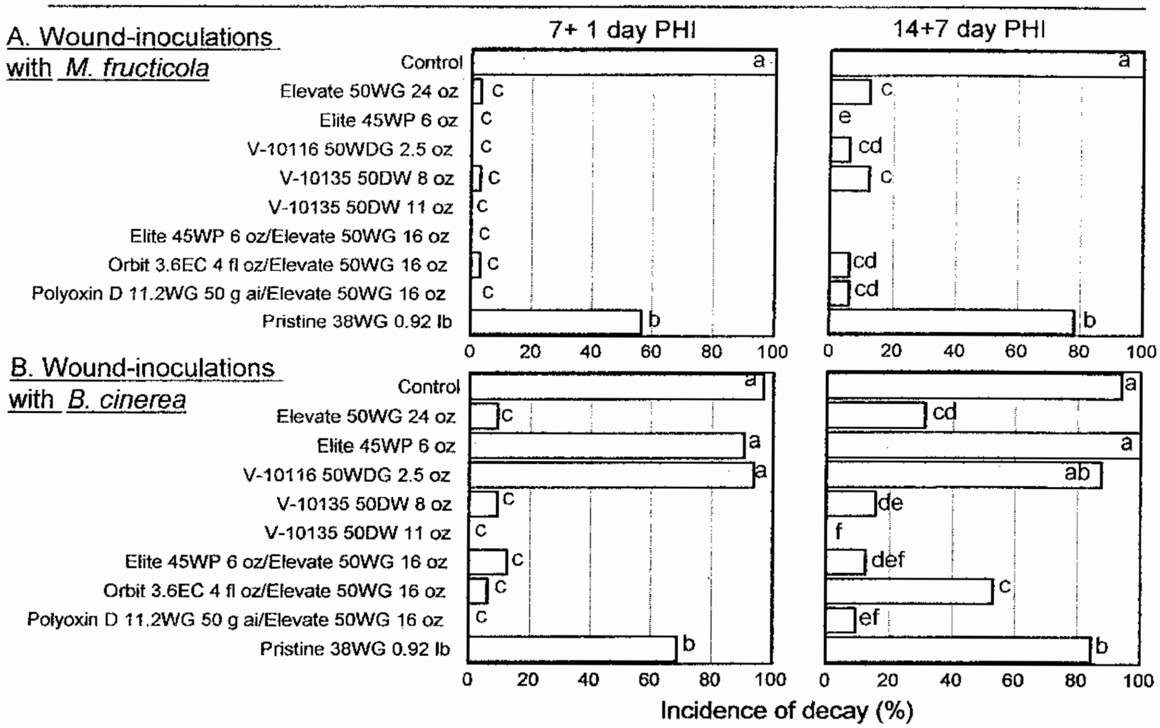
Preharvest treatments were applied on 5-16 and 5-22 using an air-blast sprayer at a rate of 100 gal/A. Washes of harvested fruit were done in a commercial hydrocooler. Fruit were spray-inoculated using a spore suspension of *M. fructicola* at 10K/ml and were incubated at 20C for 6 days.

Fig. 4. Efficacy of 7+0 and 14+7 day preharvest fungicide treatments for management of postharvest decays of Bing cherries



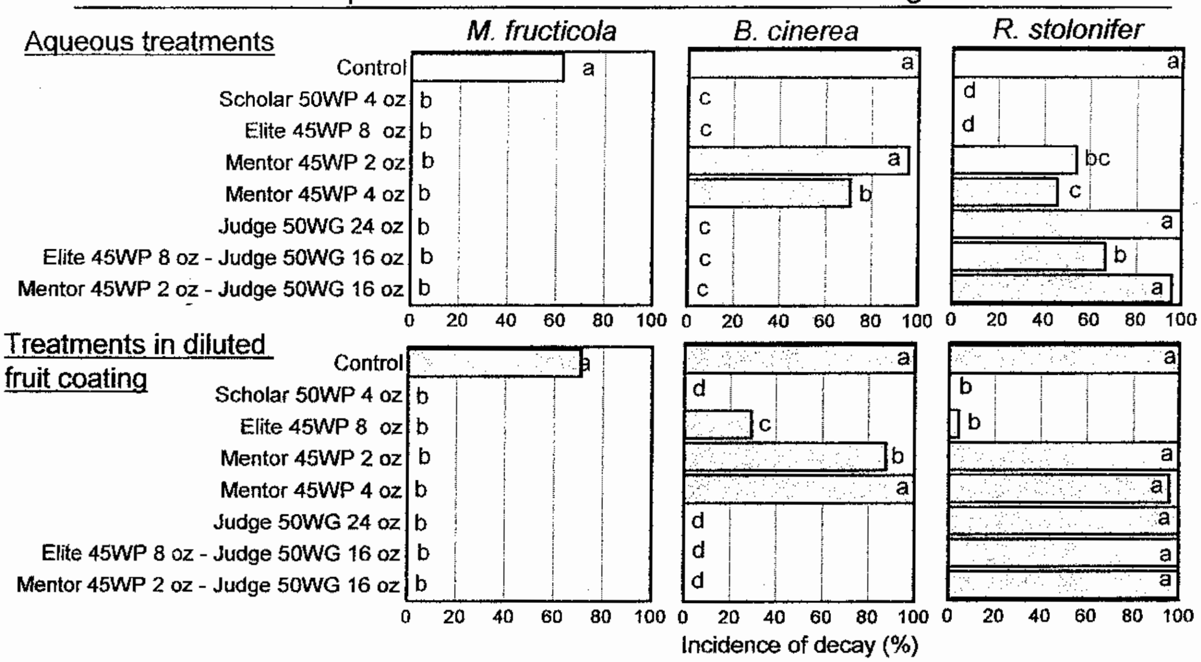
Preharvest treatments were applied on 5-16 and 5-22-07 using an air-blast sprayer at a rate of 100 gal/A. Washes of harvested fruit were done in a commercial hydrocooler. Fruit were wound-inoculated using a spore suspension of either fungus at a concentration of 30K/ml and were incubated at 20C for 6 days.

Fig. 5. Efficacy of 7+1 and 14+7 day preharvest fungicide treatments for management of postharvest decays of Bing cherries



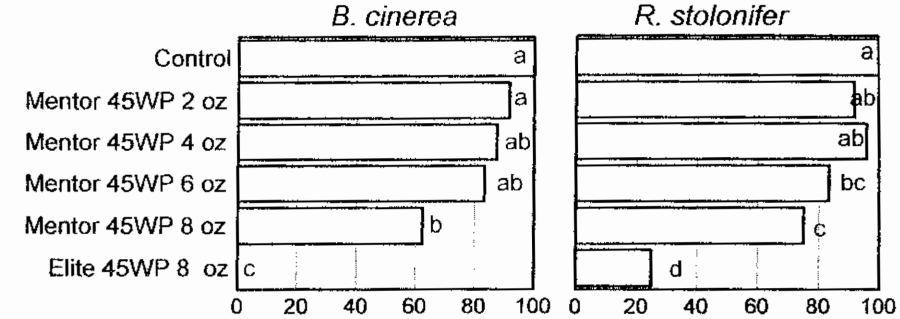
Preharvest treatments were applied on 5-15 and 5-22-07 using an air-blast sprayer at a rate of 100 gal/A. Fruit were wound-inoculated using a spore suspension of *M. frucitcola* or *B. cinerea* at a concentration of 30K/ml.

Fig. 6. Postharvest fungicide treatments for decay control of Bing cherry fruit in laboratory studies
- Comparative evaluation of new and older fungicides -



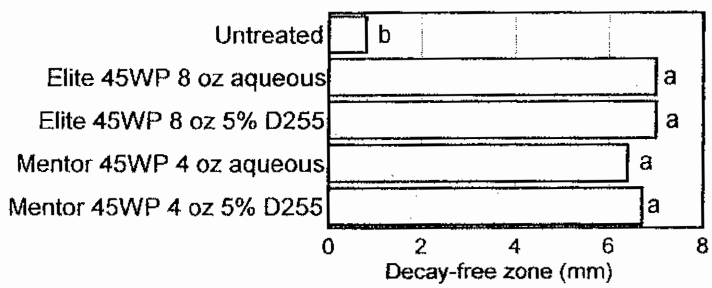
Fruit were wound-inoculated with spores of *M. fructicola, B. cinerea,* or *R. stolonifer* (30K spores/ml) and incubated for 12 h at 20C. Fruit were then treated with fungicides in aqueous solutions or diluted solutions of a fruit coating (5% D255) using an air-nozzle sprayer and incubated at 20C.

Fig. 7. Postharvest fungicide treatments with Mentor for decay control of Bing cherry fruit in laboratory studies



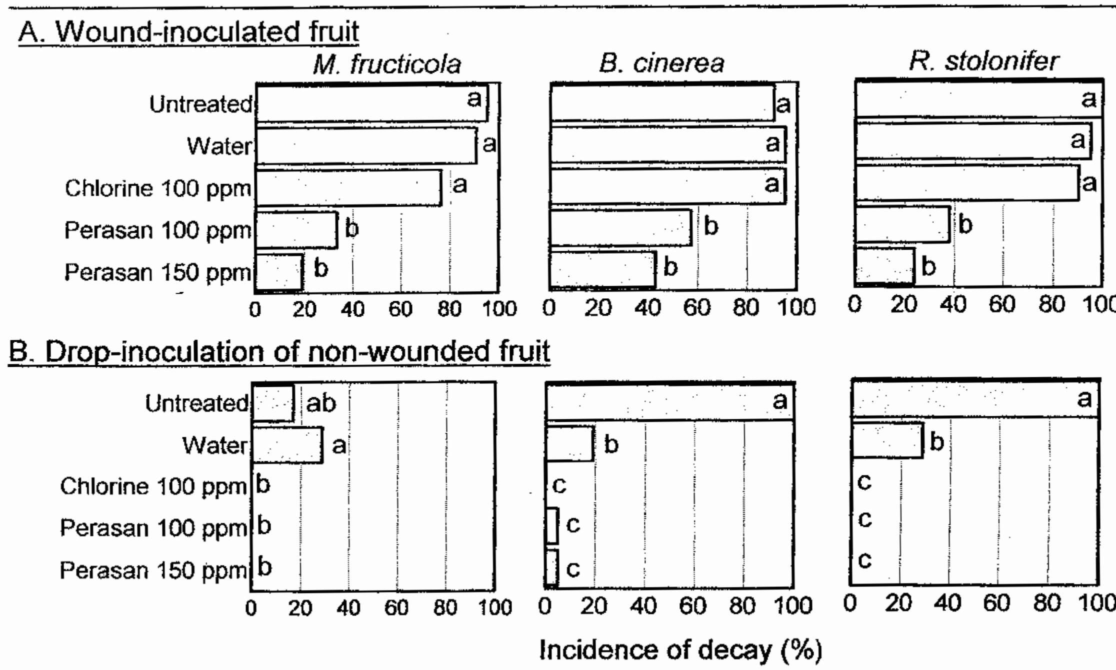
Fruit were wound-inoculated with spores of *B. cinerea* or *R. stolonifer* (30K spores/ml) and incubated for 12 h at 20C. Fruit were then treated with fungicides in diluted solutions of a fruit coating (5% D255) using an air-nozzle sprayer and incubated at 20C.

Fig. 8. Penetration of fungicides into Rainier sweet cherry fruit



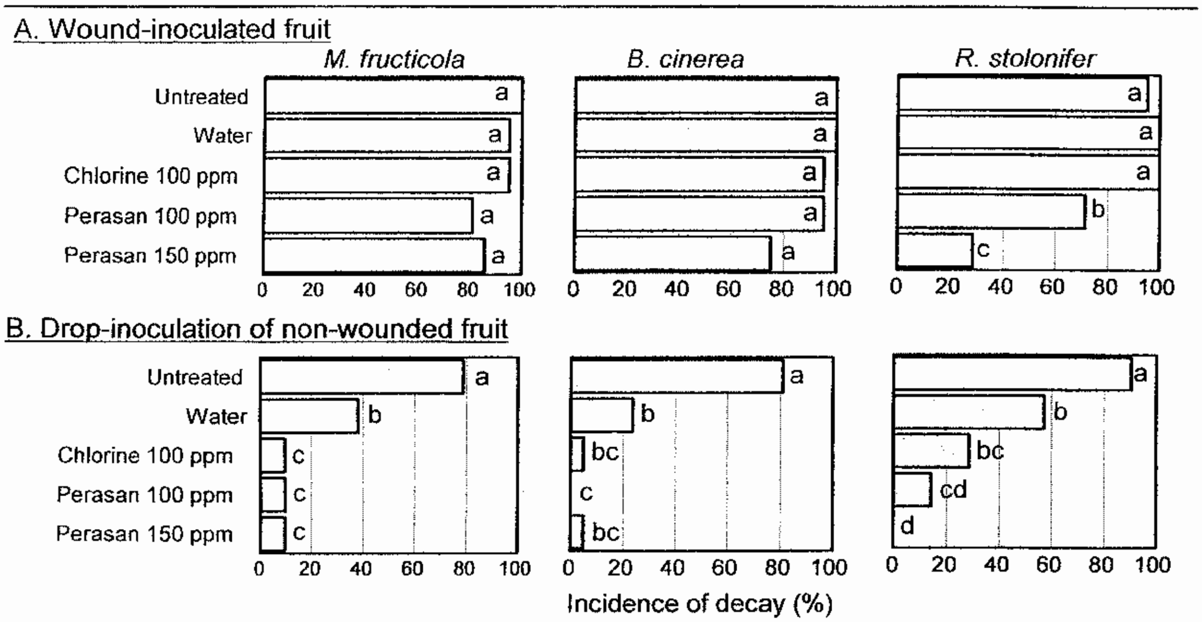
Fungicides were applied onto Rainier cherry fruit as an aqueous solution using an air-nozzle sprayer. Fruit were incubated overnight at 20C and were then inoculated at the pit with 2 ul of a conidial suspension (150K spores/ml) of *M. fructicola* using a syringe. For evaluation, fruit were cut open and the radial decay-free zone at the inoculation site between pit and epicarp was measured.

Fig. 9. Evaluation of postharvest sanitation treatments for decay control of Bing cherry fruit in laboratory studies (fruit not water-rinsed after treatment)



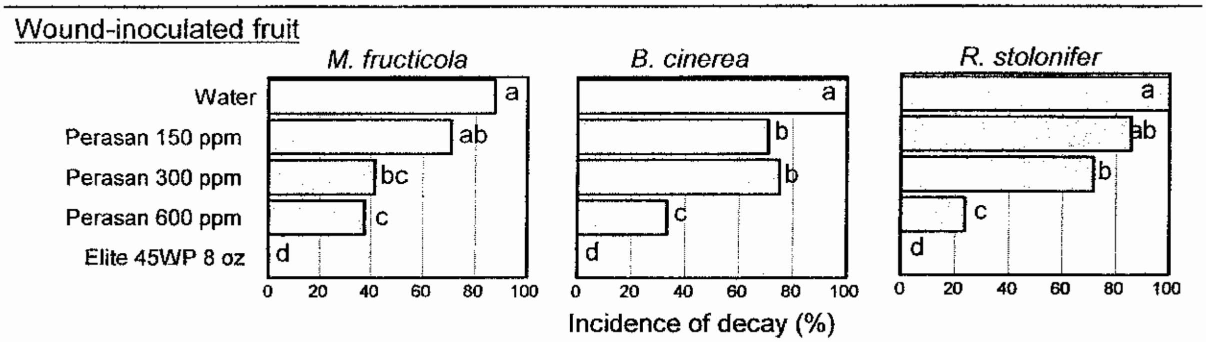
For the wound-inoculations, fruit were wounded and inoculated with spores of *M. fructicola, B. cinerea*, or *R. stolonifer* (30K spores/ml). For the drop-inoculations, drops of inoculum were placed onto non-wounded fruit. After incubation for 12 h at 20C fruit were dipped into sanitatizing solutions for 30 sec. Drop-inoculated fruit were then wounded using sterile tooth picks. All fruit were then incubated at 20C.

Fig. 10. Evaluation of postharvest sanitation treatments for decay control of Bing cherry fruit in laboratory studies (fruit water-rinsed after treatment)



For the wound-inoculations, fruit were wounded and inoculated with spores of *M. fructicola, B. cinerea,* or *R. stolonifer* (30K spores/ml). For the drop-inoculations, drops of inoculum were placed onto non-wounded fruit. After incubation for 12 h at 20C fruit were dipped into sanitatizing solutions for 30 sec and then briefly rinsed with water. Drop-inoculated fruit were then wounded using sterile tooth picks. All fruit were then incubated at 20C.

Fig. 11. Evaluation of postharvest sanitation treatments for decay control of Bing cherry fruit in laboratory studies (fruit not water-rinsed after treatment)



Fruit were wounded and inoculated with spores of *M. fructicola, B. cinerea,* or *R. stolonifer* (30K spores/ml). After incubation for 9 h at 20C fruit were spray-treated with Perasan or Elite and then incubated at 20C.