DESCRIPTION:	**Evaluation of Postharvest Treatments for Management of Gray Mold, Blue Mold and other Decays of Stored Pears in California**
PROJECT LEADER:	**Jim Adaskaveg, UC Riverside**
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Project Title:	Evaluation of Postharvest Treatments for Management of Gray Mold, Blue Mold, and other Decays of Stored Pears in California
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MAIN ACHIEVEMENTS IN 2002 RESEARCH

1. In laboratory, experimental packingline, and commercial packingline studies using inoculated pear fruit, the high efficacy of fenhexamid (Elevate) and fludioxonil (Scholar) against gray mold and against both gray mold and blue mold, respectively, as shown in our previous studies was confirmed.
2. Two new fungicides, pyrimethanil and the premix pyraclostrobin/nicobifen, were also highly effective against both postharvest pear decays.
3. The high efficacy of these fungicides was demonstrated with using TBZ-sensitive and -resistant isolates of the pathogens. TBZ treatments were ineffective using resistant isolates.
4. Mixtures of TBZ with fludioxonil or pyrimethanil (all fungicides at reduced rates) were very effective against gray mold and blue mold when either TBZ-sensitive or -resistant isolates of the pathogens were used. A mixture of TBZ with Elevate (both a full rates) was effective against TBZ-sensitive or -resistant isolates of *B. cinerea,* but not of *P. expansum*.
5. In studies where the fungus was inoculated after fungicide application, fenhexamid was very effective against gray mold, fludioxonil and pyrimethanil were effective against blue mold, and pyraclostrobin/nicobifen were effective against both decays. Thus, the fungicides have different degrees of pre-infection activity in addition to their excellent post-infection efficacy.

INTRODUCTION

Gray mold, caused by *Botrytis cinerea,* and blue mold, caused by *Penicillium expansum*, are the most important storage diseases of pears in California. Other decays that may cause significant losses include Alternaria, Phomopsis, Rhizopus, and Mucor rots. Infections commonly start at the stem end that is cut at harvest and becomes contaminated by the omnipresent spores of the pathogen. On Bartlett pears, calyx end-rot caused by *B. cinerea* is common that starts from infections during bloom. Additional entry points for all pathogens are wounds that are caused by abiotic or biotic agents before or during harvest. While some postharvest decay fungi like *Rhizopus* species are suppressed at storage temperatures of 0°C (32°F), *B. cinerea* and *P. expansum* will still grow, although slowly. Thus, additional chemical treatments are needed. Currently, Ziram is registered as a preharvest treatment on pears with a 40-day preharvest interval. Thiabendazole (Mertect 340F) and captan (Captan 50WP) are the only fungicides registered for postharvest use on pears. In our postharvest studies in 2001 using ziram (8 lb/200,000 lb) or captan (2 lb/200,000 lb), both fungicides were ineffective in reducing the incidence of gray mold and Penicillium decays in inoculated fruit. Considering the 40-day preharvest interval for ziram-treated fruit to be used for fresh market and as a food for infants, the potential beneficial effects of preharvest applications of ziram for postharvest control of gray mold or Penicillium decays of pears are considered minimal or non-existent. The lack of efficacy of captan against both decays evaluated was probably due to the low rate (2 lb/100 gal) registered. For preharvest uses, the fungicide is commonly used at 8-10 lb/100 gal. In view of the ineffectiveness of captan at the rate evaluated for the two decays, export restrictions on the fungicide in different international markets, and the visible residues of the fungicide formulation left on the fruit after treatment, captan cannot be considered a postharvest alternative. Thiabendazole can be very effective for decay control, however, resistant populations of the pathogens against the fungicide commonly occur in packinghouses, making the fungicide ineffective. We found that TBZ-resistant isolates of *P. expansum* and *B. cinerea* are common in packinghouses in California, stressing the need for postharvest alternatives to TBZ. Additional postharvest treatments recommended for postharvest decay control of pears include the biological control agent Bio-Save that was also evaluated previously by us. In these studies using different inoculum levels and TBZ-sensitive and -resistant isolates of *B. cinerea* and *P. expansum*, the efficacy of Bio-Save was inconsistent and never as good as compared the new fungicides Elevate or Scholar. Thus, from our studies that addressed EPA concerns for the Emergency Registration of fenhexamid, we conclude that there are no registered alternatives available as effective pre- or postharvest treatments for control of postharvest decays caused by TBZ-resistant isolates of *B. cinerea* or *P. expansum*. Based on these results a Section18 registration was granted in 2001 and 2002 for postharvest use of Elevate.

The efficacy of Elevate (fenhexamid) against gray mold and of Scholar (fludioxonil) against gray mold and blue mold has been demonstrated in our previous studies that were summarized in our last year's annual report for the California Pear Board. IR-4 residue studies have been completed for both fungicides. In 2002 additional laboratory, experimental, and commercial packingline studies were conducted on the efficacy, preventative and post-infection activity of Scholar and Elevate on Bartlett, Bosc, and Asian pears. In addition, two other new fungicides, PH-066 or Scala (pyrimethanil) and Pristine (BAS516; mixture of pyraclostrobin and nicobifen), were evaluated for their efficacy. PH-066 is possibly another 'reduced-risk' fungicide and belongs to the same class of fungicides as cyprodinil (anilinopyrimidines). Pristine has already been classified as a 'reduced-risk' fungicide. The owners of these compounds are very supportive for their postharvest registration. Our goal is to have several new fungicides with different modes of action registered for postharvest use on pear to be able to design resistance management strategies with fungicide mixtures and fungicide rotations to prevent insensitive populations from developing.

Objectives

1) Evaluate preharvest treatments for postharvest decay control with cyprodonil (Vangard). Labeled rates will be used. Evaluations will include natural incidence and inoculation studies.
2) Evaluate postharvest treatments with the new, reduced-risk fungicides fenhexamid (Elevate), fludioxonil (Scholar), and cyprodonil (Vangard). Studies will focus on management of gray mold and blue mold.
    i. Control of natural incidence in laboratory and experimental packingline studies.
    ii. Control of decay in inoculation studies in laboratory and experimental packingline studies (these studies have already been mostly completed).
    iii. Large-scale packinghouse studies with the most effective compounds.
3) Continue to conduct pathogen population studies to determine baseline fungicide resistance levels in selected commercial packinghouses.

MATERIALS AND METHODS

(Note that the basic experimental methods have been described in our previous Annual Report).

RESULTS AND DISCUSSION OF 2002 RESEARCH

Evaluation of preharvest fungicide applications for postharvest decay control. Preharvest applications with ziram (Ziram – 8 lb/A) were applied 5 weeks before harvest in a commercial Bartlett and Bosc pear orchard using an air-blast sprayer (100 gal/A). Pyrimethanil (Scala 27 fl oz/A) was applied 8 and 0 days PHI on Bosc pears. To evaluate the efficacy of these preharvest treatments, fruit were harvested, dipped into a commercial float tank, re-collected prior to sanitizing washes, boxed, and put into cold storage. Efficacy data based on the natural incidence of decay are pending. For this, 8 boxes of approximately 100 fruit per box were used for each treatment including the control (check) treatment.

Efficacy of new postharvest fungicides for management of decays of Bartlett, Bosc, and Asian pears. Studies were conducted in the laboratory, on an experimental packingline, and on a commercial packingline. In the laboratory, fruit were treated using an air-nozzle sprayer at a rate of 100 gal/200K fruit, whereas for the packingline studies a CDA application system was used where a rate of 20 –25 gal/200,000 lb of fruit. In the laboratory studies, TBZ, Elevate, PH-066, BAS516, and Scholar all significantly reduced the incidence of gray mold of wound-inoculated fruit when a TBZ-sensitive isolate of *B. cinerea* was used (Fig. 1A, 2). When a TBZ-resistant isolate was used, however, TBZ was ineffective, whereas the other fungicides provided the same level of control as for the sensitive isolate. Similar results using these fungicides were obtained for blue mold, except that Elevate, as is known, was ineffective against this decay. Mixtures of TBZ with Scholar or Scala (all fungicides used at reduced rates in these mixtures) reduced decay caused by TBZ-sensitive and -resistant isolates to very low levels (Fig. 2). When fruit were inoculated after treatment, Elevate, PH-066, and Pristine provided very good control against gray mold, and PH-066, Pristine, and Scholar were effective against blue mold (Fig. 1B). Thus these new fungicides have different degrees of pre-infection activity in addition to their excellent post-infection efficacy.

In an experimental packingline study where fruit were first treated using a CDA application system and then inoculated with TBZ-resistant isolates of the pathogens, Elevate and Scala reduced gray mold decay to low levels, and Scala, Pristine (BAS516), and Scholar were very effective against blue mold (Fig. 3). In another study for control of gray mold caused by a TBZ-resistant isolate of *B. cinerea*, Asian pears were first treated and then inoculated or first inoculated and then treated. For application with Elevate, Scholar, or PH-066 a wigwag application system was used. After incubation of the fruit for 5 weeks at 0-1C, there was 35% decay in the control of the inoculated-treated fruit, and 0, 1.1, or 4.5% in the Scholar, Elevate, or PH-066-treated fruit, respectively (Fig. 5). For the treated-inoculated fruit, there was 47.2% decay in the control, and 0, 36, and 35% decay in the Elevate, Scholar, and PH-066 treatments, respectively (Fig. 5). These experimental packingline studies demonstrated and confirmed the laboratory study that Pristine and Scholar are more contact materials that provide wound protection than materials that protect wounds after they are applied. The results also indicate that *P. expansum* is more sensitive at lower rates to these fungicides than *B. cinerea*. This suggests that mixtures of Scala, Pristine, or Scholar with Elevate would be advantageous once these fungicides are registered. Additional studies will be done next year to confirm these findings.

In a commercial packingline study, TBZ, a mixture of TBZ and Elevate, PH0-66, and Scholar were evaluated on wound-inoculated Bartlett and Bosc pears, again using TBZ-sensitive and -resistant isolates of *B. cinerea* and *P. expansum*. The mixture of TBZ and Elevate, PH-066, and Scholar reduced decays caused by sensitive and resistant isolates to zero or near zero levels (Fig. 4). TBZ was only effective against the sensitive isolates. Residues obtained on Bosc pear were 4.09, 1.25, 3.77, and 0.59 mg/Kg; whereas on Barlett pear, residues were 4.32, 1.2, 3.23, and 1.94 mg/Kg for fenhexamid, fludioxonil, pyrimethanil, and TBZ, respectively. Thus, these large-scale, commercial packingline studies confirmed decay control data from our laboratory studies. This indicates that our small-scale laboratory trials used in earlier research (*see* Adaskaveg, CPB Annual Report 2001) were a good model for screening new fungicides. Furthermore, both laboratory and packingline studies demonstrated the potential decay problems from resistant strains of *B. cinerea* and *P. expansum*. Elevate was also shown to be another effective mixing partner for TBZ when TBZ-resistant isolates of *B. cinerea* have to be controlled. This mixture, however, was ineffective against TBZ resistant isolates of *P. expansum*. In this same study control of natural incidence of decay will also be evaluated. Currently, this fruit is in cold storage.

Another commercial packingline study was conducted in the fall using different rates and application systems for Scholar treatments on Asian pears. The fruit is being stored at 0-1C and results for decay control are pending. Treatments used in this study were: drench or flooder, T-Jet, and CDA. The T-Jet and the CDA application systems were calibrated for 100 gal/200,000 lb of fruit, whereas the flooder was calibrated for 200 gal/200,000 lb of fruit. Residues obtained from these treatments were: 0.17, 0.25, 0.37, and 0.92 mg/Kg using T-Jet at 8 oz, T-Jet at 16 oz, CDA at 16 oz, and drench (or flooder) at 16 oz Scholar 50WP per 200,000 lb of fruit. Fludioxonil residues for the CDA treatment before brushing were 0.45 ppm as compared to 0.37 ppm after brushing. Thus, only minor amounts of the fungicide were removed from the fruit by the handling equipment. Residues on Asian pears have been difficult to obtained historically on a PVC roller bed where fruit are fairly well spaced with little movement during handling to prevent injuries. Thus at this time, based on our residue data, the most effective way to obtain a residue of fludioxonil is with the flooding system.