FINAL PROJECT REPORT
WTFRC Project Number: PR05-502 (WSU Project # 13L-3661-7366)

Project Title: Control of postharvest decay in pear

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Cooperators: **N/A**

Total Project Funding: $86,678

Budget History:

Item	Year 1: 2005	Year 2: 2006	Year 3: 2007
Salaries[1]	13,000	14,803	15,243
Benefits[2]	5,200	5,477	5,335
Wages	3,000	3,000	4,000
Benefits[3]	330	330	460
Equipment	0	0	0
Supplies[4]	4,000	4,000	4,000
Travel[5]	1,000	1,000	2,500
Miscellaneous	0	0	0
Total	26,530	28,610	31,538

Objectives:

1. Develop preharvest programs using new fungicides to control postharvest decay for long-term storage of pears.
2. Evaluate effectiveness of pre- and postharvest fungicides in controlling fruit-to-fruit spread of gray mold and Phacidiopycnis rot during storage.
3. Evaluate effectiveness of preharvest fungicides and postharvest drench with fungicides in controlling Phacidiopycnis rot.

Significant findings:

- Experiments were conducted to simulate the worst scenario in which fruit were wounded (punctures, etc.) at harvest and inoculated with pathogens. The purpose was to look at protection of the fruit at harvest by the residues of fungicides that were applied within 2 weeks before harvest. When applied within 2 weeks before harvest, the residues of Pristine and Ziram on the fruit at harvest significantly reduced infections of wounds (punctures) by Phacidiopycnis rot, but the magnitude of reduction in decay incidence was low to moderate, ranging from 54% to 64% in 2005-06 and 29% to 41% in 2006-07, compared with the nontreated control. The residues of Pristine and Ziram on the fruit at harvest did not protect wounds from infections by gray mold. In comparison with the results on Fuji and Red Delicious apples, it appears that residue levels on the fruit at harvest and susceptibility of the fruit both may affect the effectiveness of Pristine in protecting wounds from infection by gray mold. In Fuji and Red Delicious apples, Pristine applied within 2 weeks before harvest was very effective to protect wounds from infection by gray mold. D'Anjou pears may be more susceptible to gray mold than apples. A higher level of fungicide residues on d'Anjou pear fruit at harvest may be needed in order to protect wounds from infections by decay-causing pathogens. However, in addition to protecting wounds from infections by decay-causing pathogens, preharvest fungicides applied near harvest also are beneficial in reducing spore load on the surface of the fruit and eradicating some latent infections. Thus, considering all potential benefits, use of preharvest fungicides such as Pristine and Ziram is recommended for control of postharvest rots.
- In trials conducted in commercial orchards, Pristine by a ground application reduced the amount of decay in the bins by 45-61% in comparison with Pristine by an aerial application; but the aerial application of Pristine was not effective compared with the nontreated control. The results support our recommendations that a ground application to achieve good coverage is essential to the success of a preharvest fungicide program for control of postharvest rots.
- Gray mold and Phacidiopycnis rot were the two major postharvest rots in field bins (the fruit were not drenched prior to storage) in our trials conducted in commercial orchards. Pristine by a ground application was effective to control both gray mold and Phacidiopycnis rot originating from natural infections.
- When applied at 7 days before harvest, Topsin M and Pristine reduced Phacidiopycnis rot by 86% and 41% in 2005-06 and by 77% and 44% in 2006-07, respectively, in comparison with the nontreated control. It appeared that Topsin M was more effective than Pristine for controlling stem- and calyx-end Phacidiopycnis rot.
- When applied as a pre-storage drench treatment, all three postharvest fungicides were very effective in controlling stem-end and calyx-end Phacidiopycnis rot. Over the two-year trials, Mertect and Scholar reduced stem- and calyx-end Phacidiopycnis rot by 94-95% and 88-97%, respectively, in comparison with the nontreated control. Penbotec was highly effective and no decay developed in the fruit treated with Penbotec.
- The residues of Pristine and Topsin M applied at 7 days before harvest on pear fruit were able to suppress the fruit-to-fruit spread of gray mold during storage. Topsin M was more effective than Pristine in suppressing the fruit-to-fruit spread of gray mold. Among the three postharvest fungicides, when applied as a pre-storage drench treatment, Penbotec was not effective in

suppressing fruit-to-fruit spread of gray mold, whereas Mertect and Scholar reduced gray mold resulting from fruit-to-fruit spread by 69% and 73%, respectively, in comparison with the nontreated control.

Methods:

Effectiveness of preharvest applications of Pristine, Topsin M, and Ziram in controlling postharvest gray mold and Phacidiopycnis rot was evaluated on d'Anjou pears. Treatments were arranged in a randomized complete block design with four replicates (1-2 trees in each replicate of each treatment). Fungicides were applied within 2 weeks before harvest. Fruit were harvested from each tree. Fruit from four replicates of each treatment were wounded with a finish nail head and inoculated with spore suspensions of *B. cinerea* and *Phacidiopycnis piri*. Fruit were tray-packed in poly liners, and then stored in RA cold storage. Incidence and severity of gray mold and Phacidiopycnis rot were determined periodically for up to 10 weeks of storage.

Experiment was conducted to determine effectiveness of pre- and postharvest fungicides in controlling fruit-to-fruit spread of gray mold and Phacidiopycnis rot during storage. Selected preharvest fungicides were applied within 2 weeks before harvest. Fruit from the nontreated and fungicide-treated treatments were harvested. Part of the nontreated fruit from the orchard was drenched with each of the three postharvest fungicides (Mertect, Penbotec and Scholar). Fruit were stored in cardboard pear-boxes, and two inoculated fruit (either gray mold or Phacidiopycnis rot) were placed in each box. Fruit were stored in CA for 6 months, at which time the number of decayed fruit resulting from fruit-to-fruit spread in each box was determined.

To evaluate effectiveness of preharvest and postharvest fungicides in controlling Phacidiopycnis rot originating from infections of stem and calyx of the fruit, fruit were inoculated with the fungus during the pear-growing season. Part of inoculated fruit was sprayed with selected fungicides within 14 days before harvest, and a nontreated control also was included. All fruit were harvested. Part of the non-fungicide-treated fruit was treated with one of the three postharvest fungicides. Fruit were then stored in air at 32˚F. Decay development will be evaluated periodically for up to 7 months after harvest, starting 3-4 months after harvest.

Results and discussion:

Preharvest fungicides for control of Phacidiopycnis rot and gray mold originating from infections of wounds.

Experiments were conducted in 2005-06 and 2006-07 seasons to evaluate preharvest fungicides for control of Phacidiopycnis rot and gray mold originating from infections of wounds on the fruit. Our trials were conducted to simulate the worst scenario in which fruit were wounded (punctures, etc.) at harvest and inoculated with pathogens. The purpose was to look at protection of the fruit at harvest by the residues of fungicides that were applied within 2 weeks before harvest.

In both seasons, we obtained similar results on the performance of Pristine and Topsin M (Fig. 1). In 2005-06, when applied at 7 and 14 days before harvest, Pristine was effective against Phacidiopycnis rot and reduced Phacidiopycnis rot by 54-64% in comparison with the nontreated control (Fig. 1). Surprisingly, Pristine was not effective to protect wounds from infections by gray mold on d'Anjou pears in this trial. Ziram applied at 2 weeks before harvest reduced gray mold by 11% and Phacidiopycnis rot by 24% on wound-inoculated fruit as compared with the nontreated control. Topsin-M applied at 7 days before harvest reduced gray mold by 15% and was not effective to reduce Phacidiopycnis rot on wound-inoculated fruit. In 2006-07, Topsin M did not protect wounds on the fruit from infections by Phacidiopycnis rot and gray mold. Pristine and Ziram significantly reduced infections of wounds by Phacidiopycnis rot, but the magnitude of reduction in decay incidence was low to moderate, ranging from 29% to 41%, compared with the nontreated control.

In comparison with the results we have done on Fuji and Red Delicious apples, it appears that residue levels on the fruit at harvest and susceptibility of the fruit both may affect the effectiveness of Pristine in protecting wounds from infection by gray mold. In Fuji and Red Delicious apples, Pristine

applied within 2 weeks before harvest was very effective to protect wounds from infection by gray mold. D'Anjou pears may be more susceptible to gray mold than apples. A higher level of fungicide residues on d'Anjou pear fruit at harvest may be needed in order to protect wounds from infections by decay-causing pathogens. However, in addition to protecting wounds from infections by decay-causing pathogens, preharvest fungicides applied near harvest also are beneficial in reducing spore load on the surface of the fruit and eradicating some latent infections. Thus, considering all potential benefits, use of preharvest fungicides such as Pristine and Ziram is recommended for control of postharvest rots.

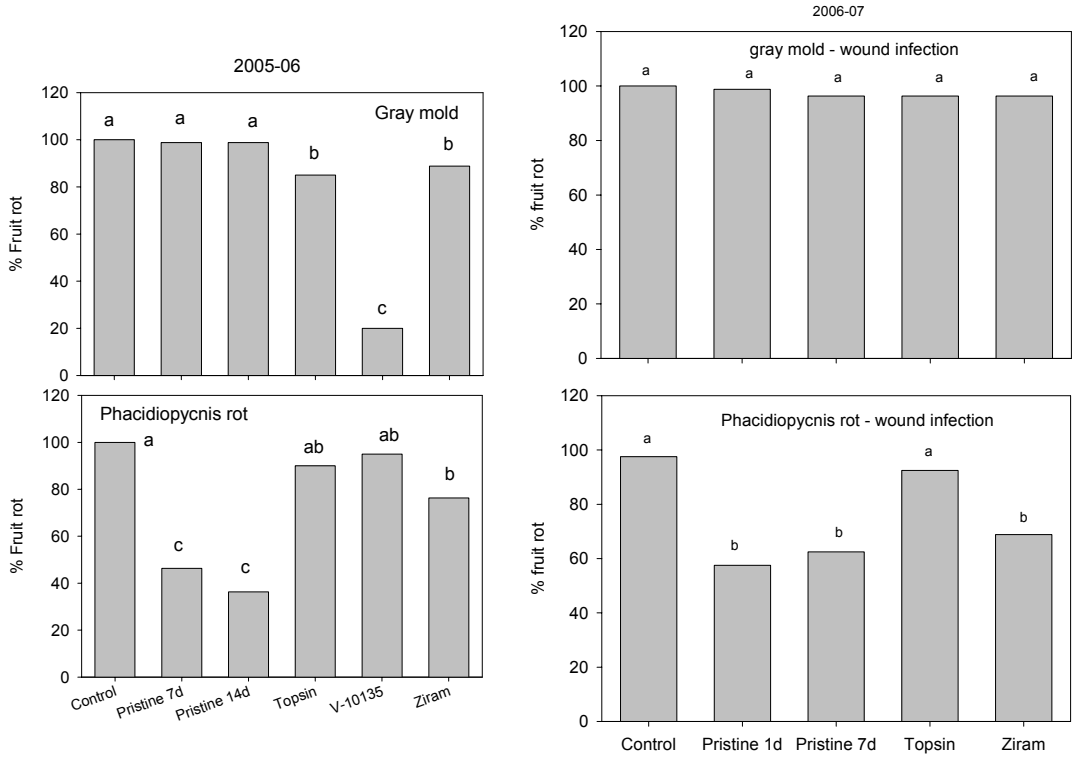

Fig. 1. Effectiveness of preharvest fungicides in controlling postharvest gray mold and Phacidiopycnis rot originating from infections of wounds on d'Anjou pears in 2005-06 and 2006-07 seasons. Pristine was applied at 1, 7 or 14 days before harvest. Topsin M, V-10135, and Ziram were applied at 7 days before harvest.

Preharvest Pristine by air and by ground applications for control of postharvest gray mold and Phacidiopycnis rot conducted in commercial orchards.

The trials were conducted on the 2005 crop in four commercial orchards. Decay assessment was done in the spring of 2006. Incidence of rots in storage bins varied from orchard to orchard. Orchard 1 and Orchard 2 had 7.6% and 5.2% rots in the nontreated fruit, respectively. The other two orchards had approximately 3% rots. Significant differences in decay control between air and ground applications were observed in Orchard 1 and Orchard 2 (Fig. 2). No significant difference in decay control between the two application methods was seen in Orchard 3 and Orchard 4, likely due to relatively lower levels of rots in these two orchard lots.

Pristine by a ground application (200 gallons per acre) reduced the amount of decay in the bins by 61% in Orchard 1 and by 45% in Orchard 2 in comparison with Pristine by the air application. In these two grower lots, Pristine by air application did not significantly control rots compared with the nontreated control. The results suggest that a high-gallonage spray by a ground application to achieve good coverage is essential to the success of a preharvest fungicide program for control of postharvest rots.

In these four grower lots, gray mold and Phacidiopycnis rot were the two major rots in field bins (the fruit were not drenched prior to storage). This is consistent with our report that gray mold and Phacidiopycnis rot are the primary target diseases in field bins if the fruit are not treated with postharvest fungicides prior to storage. In our trials conducted in commercial orchards, Pristine was effective to control both gray mold and Phacidiopycnis rot originating from natural infections. In Orchard 1 and Orchard 2, Pristine by a ground application significantly reduced gray mold and Phacidiopycnis rot compared with Pristine by an air application (Fig. 3). Blue mold and bull's eye rot were low in these trials.

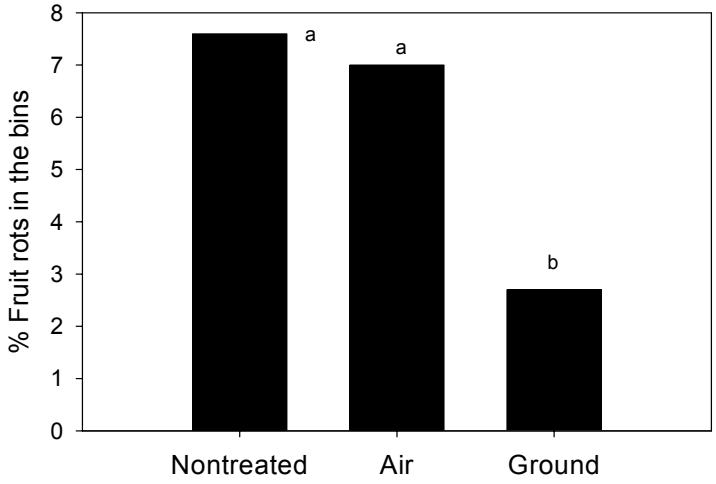

Fig. 2. Comparison of actual losses of d'Anjou pear fruit in field bins between the fruit treated with Pristine applied by a ground application (200 gallons/A) and the fruit treated with Pristine applied by an aerial application. The fruit were not drenched prior to storage. The fruit were stored in CA for 5 months, at which time decay was assessed. Percentage of fruit rots in field bins was expressed as weight of decayed fruit in the total weight of the fruit in a bin.

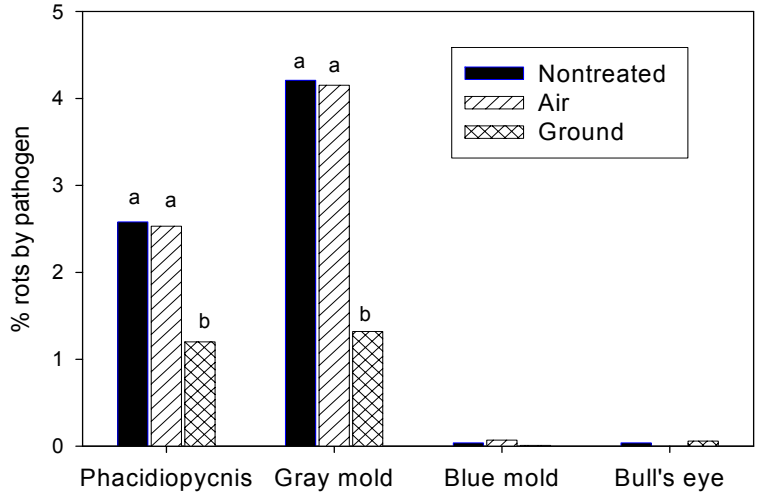

Fig. 3. Comparison of gray mold and Phacidiopycnis rot between the fruit treated with Pristine applied by a ground application (200 gallons/A) and the fruit treated with Pristine applied by an aerial application. The fruit were not drenched prior to storage. The fruit were stored in CA for 5 months, at which time decay was assessed. Percentage of fruit rots in field bins was expressed as weight of decayed fruit in the total weight of the fruit in a bin.

Pre- and postharvest fungicides for control of stem- and calyx-end Phacidiopycnis rot.

Stem-end rot and calyx-end rot are two common types of symptoms of Phacidiopycnis rot in d'Anjou pears. Fruit infected by the fungus at the stem and calyx may not have symptoms at packing, but symptoms develop in the boxes before shipping or after shipping.

Experiments were conducted in 2005-06 and 2006-07 seasons. An experiment also was conducted on 2007 crop to examine the effects of timing of fruit infection on control of Phacidiopycnis rot. The 2007 experiment is still in progress.

Both Pristine and Topsin M applied at 7 days before harvest were effective. In 2005-06, Topsin M and Pristine reduced Phacidiopycnis rot by 86% and 41%, respectively, in comparison with the nontreated control (data has been reported in 2006 report). In 2006-07, Topsin M and Pristine reduced Phacidiopycnis rot by 77% and 44%, respectively (Fig. 4). It appeared that Topsin M was more effective than Pristine for control of stem- and calyx-end Phacidiopycnis rot.

Three postharvest fungicides also were evaluated. When applied as a pre-storage drench treatment, all three postharvest fungicides were effective to control stem-end and calyx-end Phacidiopycnis rot (Fig. 4). Over the two-year trials, Mertect and Scholar reduced stem- and calyx-end Phacidiopycnis rot by 94-95% and 88-97%, respectively, in comparison with the nontreated control. Penbotec was highly effective and no decay developed in the fruit treated with Penbotec.

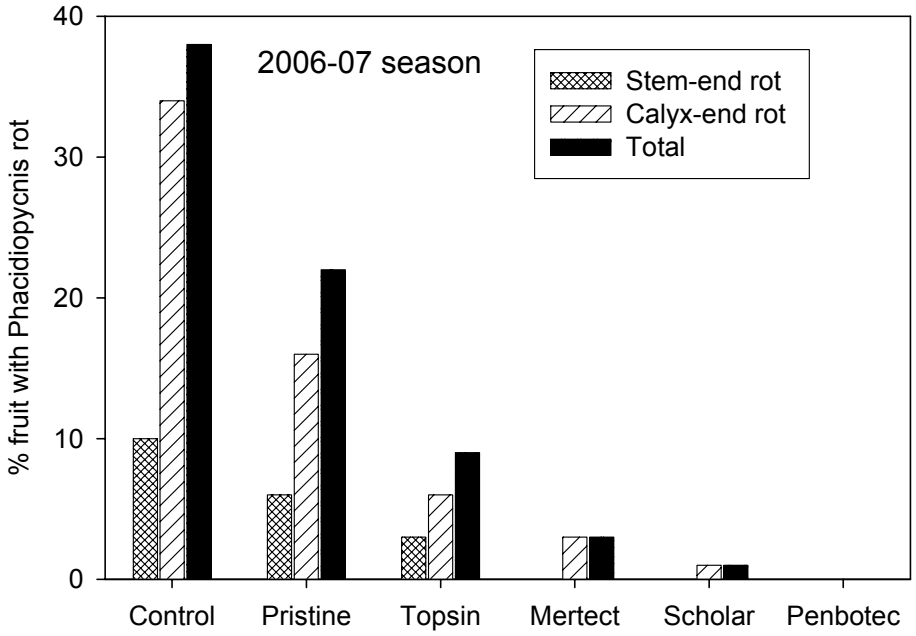

Fig. 4. Control of stem- and calyx-end Phacidiopycnis rot with pre- and postharvest fungicides conducted in 2006-07. The fruit were inoculated with the pathogen in the orchard at 3 weeks before harvest. Pristine and Topsin were applied at 7 days before harvest, and Mertect, Scholar and Penbotec were applied the same day after harvest. Fruit were stored at 32ºF in RA. Decay incidence at 7 months after harvest was presented.

Postharvest fungicides for control of Phacidiopycnis rot originating from wound infections.

The results from the 2006 and 2007 experiments are summarized in Table 1. After 10 weeks in cold storage, 78-99% of the non-treated fruit had Phacidiopycnis rot. No decay developed on the fruit treated with the new formulation of Scholar at 16 fl oz/100 gallon or Penbotec when the treatment was applied one hour after inoculation. Scholar applied 24 h after inoculation reduced Phacidiopycnis rot by over 95% compared with the nontreated control. Penbotec applied 24 h after inoculation reduced Phacidiopycnis rot by 98% in 2006 and 100% in 2007. The results indicate that the three postharvest fungicides have post-infection activities against Phacidiopycnis rot when applied as a pre-storage

treatment and that a pre-storage drench treatment applied within 24 h after harvest is effective in controlling Phacidiopycnis rot originating from infection of wounds.

Table 1. Efficacy of Scholar or Penbotec as a drench treatment for control of Phacidiopycnis rot originating from infection of wounds.

	% of Fruit Infected	
Treatment	2006	2007
Nontreated control	77.9	98.8
Mertect 16 fl oz applied 1 hr after inoculation	0	3.8
Mertect 16 fl oz applied 24 hr after inoculation	5	1.3
Scholar 230SC 16 fl oz applied 1 hr after inoculation	0	0.0
Scholar 230SC 16 fl oz applied 24 hr after inoculation	3.3	2.5
Penbotec 16 fl oz applied 1 hr after inoculation	0	0.0
Penbotec 16 fl oz applied 24 hr after inoculation	1.7	0.0

Effectiveness of fungicides in controlling fruit-to-fruit spread.

Experiments were conducted in the 2005-06 and 2007-08 seasons. The 2007 experiment is still in progress. Results will be forthcoming. In the 2005-06 experiment, Phacidiopycnis rot was low. Only the data on gray mold are presented (Fig. 5). When applied at 7 days before harvest, the residues of the two preharvest fungicides (Pristine and Topsin) on pear fruit were able to suppress the fruit-to-fruit spreading of gray mold during storage. Topsin was more effective than Pristine in suppressing the fruit-to-fruit spread of gray mold. Among the three postharvest fungicides, when applied as a pre-storage drench treatment Penbotec was not effective in suppressing fruit-to-fruit spread of gray mold, whereas Mertect and Scholar reduced gray mold resulting from fruit-to-fruit spread by 69% and 73%, respectively, in comparison with the nontreated control (Fig. 5).

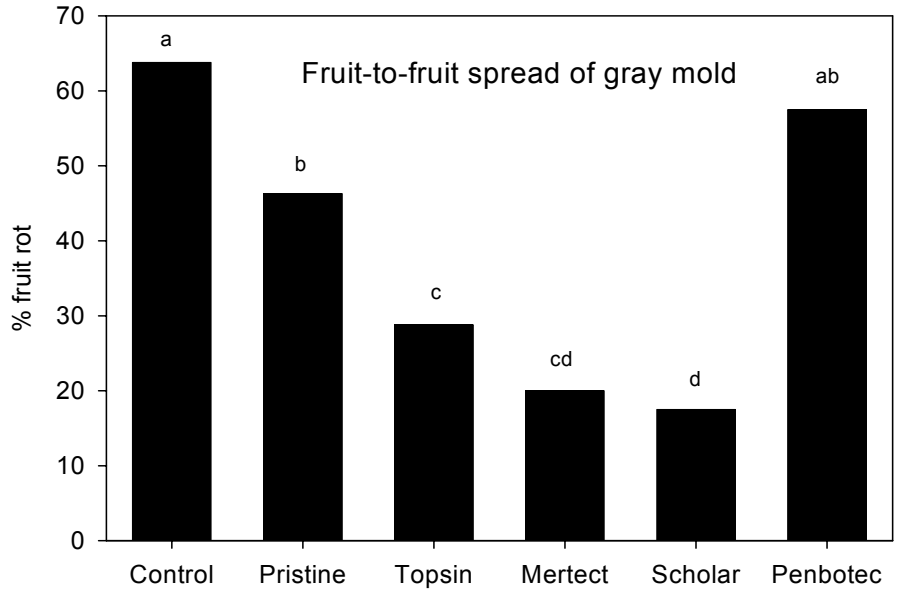

Fig. 5. Effectiveness of preharvest fungicides applied at 7 days before harvest and postharvest fungicides applied as a pre-storage drench treatment in suppressing fruit-to-fruit spread of gray mold in d'Anjou pears during storage.