DESCRIPTION:	**Evaluation of New Bactericides for Control of Fire Blight of Pears Caused by *Erwinia amylovora***
PROJECT LEADER:	**Jim Adaskaveg - UC Riverside and Doug Gubler - UC Davis**
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Project Title:	Evaluation of new bactericides for control of fire blight of pears caused by *Erwinia amylovora*
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SUMMARY

1. For a second year, the DOW bactericide and the antibiotic Starner were highly effective in field studies as blossom and foliar spray treatments against fireblight. Efficacy was similar to the industry standard terramycin. Three formulations of the DOW bactericide were evaluated. All three were effective in one of the trials, whereas only one of them was effective in the second trial. Because of the importance of proper formulation, additional new agricultural formulations need to be made and evaluated in field trials
2. New copper and silver formulations were effective in reducing fireblight in an experimental orchard.
3. Phytotoxicity as measured by fruit russeting was not significantly different between the control or terramycin treatments and any of the experimentals evaluated. One of the DOW biocide formulations caused another type of fruit symptoms, that was, however, almost absent in the most effective formulation of the material.

INTRODUCTION

Fire blight, caused by the bacterium *Erwinia amylovora,* is a very destructive disease of pome fruit trees worldwide. Of all the pomaceous crops, the disease is most severe on pears. In addition to cankers, the pathogen overwinters in flower buds, diseased fruit, small twigs, and branches left on the ground after pruning. In the spring, blossoms are infected through natural openings in nectaries, and pistils. After destroying the blossoms, the bacteria spread into the peduncles and spurs. During warm, humid weather ooze droplets consisting of new inoculum are exuded from the peduncles. Young fruitlets often become infected, and they also turn black, dry, shrivel, but usually remain attached to the tree. The disease spreads rapidly and the bacteria invade adjacent leaves through stomata, trichomes, hydathodes, but more frequently through wounds caused by hail or wind whipping. Succulent twigs, suckers, sprouts, and shoots are the next tissues infected. Secondary infections may occur throughout the growing season. Inoculum is spread by wind, rain, insects, birds, or by man, e.g. by means of contaminated pruning tools. Primary and secondary infections may spread into the branch. At this time the infection, if walled off, produces a canker or it penetrates further into the branch and then into the trunk. From here the bacteria may move into other branches. If uncontrolled, eventually the whole tree will die. The disease can be very severe in some years, causing repeated infections during warm and wet weather.

Control measures. Fire blight is very difficult to control. Even with an integrated program of chemical control combined with sanitation and orchard management this serious disease is almost impossible to eliminate with the current methods available. Thus, every effort should be made to keep the disease out of the orchard. If the disease is in its early stage and only a few twigs are blighted it often can be eliminated by pruning. Current chemical control programs for fire blight control are based on protective schedules, because

[1] - Special thanks to Layne Wade of Naumes Packing Co. for his extensive efforts in assisting in applications of bactericides and evaluating the trial in Marysville, CA.

available compounds are contact treatments and are not systemic. Copper compounds have been used since the early 1900s, mostly in the form of copper sulfate plus lime (Bordeaux mixture). Control with copper compounds is only satisfactory when disease severity is low to moderate. Copper treatments are widely used only during dormant and bloom periods because phytotoxic effects commonly occur on fruit as russeting. Streptomycin, an antibiotic for blight control, came into general commercial use during the late 1950s, followed by the less effective oxytetracycline (Terramycin). Because of the lack of alternative control materials, antibiotics are still being used commercially, although pathogen resistance against the antibiotic is widespread and concerns are growing regarding using antibiotics in agriculture that are also used in human medicine.

New, more effective materials for fire blight control have to be developed to combat this destructive disease. These materials should be locally systemic and not phytotoxic and should target multiple sites of action within the bacterial pathogen or have a mode of action different from currently used bactericides. Materials with different modes of action could then be incorporated into a resistance management program. Systemic formulations could be used in trunk and branch injections to eliminate the primary inoculum of the pathogen, while protective treatments could be used topically to prevent spread and infection of secondary inoculum. During the past years we have identified a broad spectrum biocide (DOW-01 – Dow Chemicals) that is registered as a water treatment, and that is highly toxic at low concentrations in *in vitro* assays against bacterial plant pathogens (e.g. species of *Xanthomonas*), is very active against bacterial spot of peppers in greenhouse experiments, and has significantly reduced walnut blight incidence in field trials. In the first year of our fire blight trials (2001) we found that two formulations of this compound significantly reduced the incidence of the disease, similar to terramycin (Mycoshield). Two new formulations of this promising material, that were formulated for agricultural use, were made available for our 2002 trials by the manufacturer. Other compounds evaluated are the antibiotic Starner, the activated host resistance compound Vacciplant, and new copper- (Bioacumen) and silver-based (Axenohl) products. These materials also showed similar efficacy to terramycin in our preliminary field trial in 2001. Thus, in 2002 we conducted additional field experiments for the evaluation of new potential fire blight control chemicals.

OBJECTIVES

A) Laboratory in vitro tests to evaluate the bactericidal activity: Direct contact assays, filter disk assays, amended agar assays.
B) Evaluate the toxicity of new copper-based (Bioacumen, Magna-Bon) materials and alternative, non-copper based chemicals to *E. amylovora*: DBNPA, Starner, and compare efficacy to copper and streptomycin.
C) Laboratory in vitro tests to evaluate the bactericidal activity: Direct contact assays, filter disk assays, amended agar assays.
D) Field studies with protective spray treatments. Applications will be made based on existing Fireblight forecasting models starting at bloom.
E) Field studies with mixtures of antibiotics and biocides. Applications based on an existing Fireblight model starting at bloom.

RESULTS AND DISCUSSION

Two field trials on Bartlett pear were conducted using bactericides and antibiotics as protective spray treatments, one in a commercial orchard in Marysville and one in an experimental orchard in Davis, CA. Seven treatments between the end of March to early May were applied in the Marysville orchard, and six treatments were applied in the Davis orchard based on a temperature-threshold model. At the first evaluation date in the Marysville orchard (May 1), one formulation of the DOW bactericide, Starner, Vacciplant, and the mixture of Starner and Vacciplant significantly reduced the number of blight strikes per tree from 2.6 strikes in the untreated the control to 0.2 to 0.6 strikes (Fig. 1A). Reduction in disease by these treatments was numerically similar to the standard terramycin (Mycoshield) treatment that had an average of 0.8 strikes per tree. Thus, only one of the DOW chemical formulations was highly effective. At the second evaluation (May 21), a significant reduction in disease was only found in the Starner and Starner/Vacciplant treatments. At this date there was an average of 1.7 strikes per tree in these latter treatments as compared to 5.8 strikes in the control. Terramycin had similar disease levels as the control. Differences between treatment efficacies at the two evaluation dates can be explained by the fact that no applications were done for 11 days before the second evaluation, and treatments may not have persisted over this time. Thus, although very effective at the first evaluation date, still better formulations of the DOW material could be developed for agricultural use. The non-persistence of the chemical, however, can also be considered a positive characteristic. Thus, the chemical quickly dissipates, potentially leaving no residues in the developing pear fruit. This aspect of the bactericide possibly could facilitate its registration by EPA. Thus, residue studies will be needed to fully characterize the persistence of the DOW biocide. This will be part of our objectives in 2003.

Phytotoxicity evaluations on pear fruit were made at harvest. There were no significant differences in the incidence of russeting between the control and any of the treatments, including terramycin (Fig. 1B). Numerically, the DB918-48C had the lowest incidence. This formulation was also the one that had the lowest disease incidence among the three formulations evaluated. This stresses the importance of proper bactericide formulation and indicates that other new formulations may be even more effective. One of the DOW material formulations (DB918-54A) caused another kind of phytotoxicity symptoms in form of faint pigmented circles or rings approximately 10-15 mm in diameter. These circles were absent in the DB117-2 formulations and were present at very low levels in the DB918-48C formulation.

In the second field trial at the Davis orchard, disease was numerically reduced by all treatments evaluated (Fig. 2). Differences between the Vacciplant treatments and the control, however, were not significant. All three formulations of the DOW bactericide, two rates of Starner, the mixture of Starner and Vacciplant, and the copper or silver formulations Bioacumen and Axenohl, respectively, significantly reduced the incidence of fire blight based on the number of strikes per tree, similar to terramycin. Furthermore, there was no significant difference between the treatments that ranged from antibiotics, biocides, to copper/silver based treatments. Because the number of fruit in this experimental orchard was very low, no evaluations for phytotoxicity or russeting effects on fruit caused by the treatments were made. No phytotoxicity was observed on leaves for any of the treatments.

Thus, for a second year the DOW bactericide and the antibiotic Starner significantly reduced the incidence of fireblight similar to the standard terramycin. The DOW bactericide should be further evaluated in future trials. Starner is known to develop resistance in pathogen populations and antibiotics are generally not being developed in agriculture anymore because of their importance in medicine. Thus, we will not continue further evaluations with this antibiotic. The importance of finding an alternative material to antibiotics for fireblight control is still imperative. To develop an integrated management program new materials have to be introduced and used in conjunction with existing compounds. The systemic resistance inducer Vacciplant was effective in one trial in 2001 and in our Marysville trial in 2002, but not in the UC Davis trial with higher disease incidence (although there was a trend for lower disease incidence) and where only two applications were made during bloom. In the Marysville trial, seven applications were made from bloom to early fruit development (mid-May). Thus, the inconsistency in efficacy with the number of applications is a concern but the SAR compound may be effectively used in a program with terramycin or streptomycin.

The new copper and silver formulations Bioacumen and Axenohl, respectively, were also effective. EPA, however, may not accept silver-based materials for registration due to environmental persistence and mammalian toxicity problems. This was discussed with the potential registrant of the material and regulatory responses are pending. The new copper material Bioacumen performed well although no clear advantage of this product from other copper products could be determined in regard to efficacy and due to lack of phytotoxicity evaluations.

Laboratory studies are ongoing and will be summarized in next year's report.