Integrating variable rates of Kocide 3000® in a blight management program

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Abstract

Three bactericidal programs were compared in 2009 for fire blight incidence and fruit russetting in a mature pear orchard (*Pyrus ×communis* 'Bartlett'): 1) Season-long use of Mycoshield, 2) Season-long use of Kocide 3000 + Manzate Pro Stick (K+MPS), and 3) K+MPS up to April 8 and Mycoshield April 14 through April 21. Each plot was four rows wide by approx. 100 trees long and each was replicated four times. On May 7, little blight was found (0.11 to 0.27 strikes/tree) and there were no significant differences between treatments. On July 13, mostly older shoot strikes were found, and the season-long K+MPS had significantly fewer strikes (0.6 strikes/tree) than Mycoshield alone (1.5 strikes/tree) or K+MPS followed by Mycoshield (1.7 strikes/tree). Over an inch of rain fell in early May, so the presence of residual copper on the foliage likely enhanced control of the shoot strikes. In 2010, treatments in the same orchard were: 1) Season-long use of Mycoshield, 2) Season-long use of K+MPS, both at full label rate, and 3) Season-long use of Kocide 3000 at half the label rate + Manzate Pro Stick at full label rate. Each plot was six rows wide by approx. 100 trees long and each was replicated four times. There were no significant differences among treatments in the number of blight strikes per tree at the first cutting in early June 2010 (1.4 to 1.5 strikes/tree) or in the second evaluation on July 9 (0.90 to 0.91 strikes/tree). Very little russetting was found in 2009 or 2010, with significant differences among treatments.

Introduction

Control of fire blight with antibiotics is a costly program. Resistance in the pathogen *Erwinia amylovora* to streptomycin is widespread in many parts of the Sacramento district (Adaskaveg and Gubler 2007), but in many orchards Mycoshield (oxy-tetracycline) is generally less effective than Agri-Mycin (streptomycin). Most copper products induce russetting on Bartlett pear fruit, but Kocide 3000 has been used by several Sacramento district growers since 2007, with good blight control and little or no additional russetting. However, spring weather from 2007 through 2009 was relatively dry. In 2010 there was substantially more spring rain, and there were reports of increased overall russetting in some orchards where Kocide 3000 was used.

A variety of copper compounds are registered for use on pears. Many growers previously used copper dust. Fixed copper and Bordeaux mixture are also available for use, but are seldom used on Bartlett due to the russetting potential. Copper applications must be made when fruit are dry and temperatures are not excessively cool or hot, or russetting may occur. As a group, copper compounds are less effective in controlling fire blight and are more phytotoxic than antibiotics. The severity of phytotoxicity depends on the compound used, timing with respect to stage of growth, formulation and concentration used, and the pear variety (van der Zwet and Beer 1995).

Kocide 3000 (copper hydroxide) has reduced Metallic Copper Equivalent (30% MCE) compared to Kocide 2000 at 35% MCE and Kocide 101 at 50% MCE. Kocide 3000 can be applied at 2/3 the rate of Kocide 2000. Kocide 3000 also has improved worker safety, including the signal word 'caution', no PPE eyewear is required, and no early entry eyewear is required.

The signal word for Kocide 2000 is ‘warning’ and that for Kocide 101 is ‘danger’. The Kocide 3000 label for pear says, “Apply at 5 day intervals or as needed throughout the bloom period.” It also says, “NOTE: Russetting may occur in copper sensitive varieties. Excessive dosages may cause fruit russet on any variety.”

In a study in which apples (*Malus* ×*domestica* ‘Granny Smith’) were treated in the field with 113 g/3.8 L cupric hydroxide (50% MCE) at bloom, more than 60% were russetted at harvest (Teviotdale and Viveros, 1999). No rainfall occurred during the experiment. At the high label rate for Kocide 3000, 0.5 lb. applied in 100 gal./acre water is only 2.3 g/3.8 L.

The blight program for several Sacramento County growers from first bloom through about April 8 from 2007 to 2009 consisted of Kocide 3000 (0.5 lb./100 gal.) about twice a week plus Dithane (3.2 lbs./acre) once a week, followed by Mycoshield after April 8 (during the secondary bloom period). Dithane (mancozeb) is often used for scab control, and it is labeled for blight control when used with copper; it is also believed by some to reduce the potential for russetting. Starting in 2009, Dithane was not available so growers instead used Manzate, which has the same ingredients as Dithane.

Some growers successfully used Kocide 3000 + Dithane or Manzate all season long with no additional russetting. Starting in 2010, at the urging of University of California researchers, these growers began to rotate Kocide 3000 with antibiotics to reduce the potential for the development of copper resistance. Although copper resistance has not been found in pears, it is widespread in walnuts in California and the Pacific Northwest from overuse of copper products (Scheidt 2008, UC IPM 2007). A blight program that integrates Kocide 3000 with antibiotics would be a better strategy for reducing resistance. Recent U.S. Environmental Protection Agency re-registration and risk assessments may mean that fewer copper fungicide applications can be used per year (J. Adaskaveg, personal communication; EPA, 2006).

Methods and Materials

The trial was conducted in a mature Bartlett pear orchard in Sacramento County. Orchard spacing was 16 between rows x 10 ft. between trees. A randomized, complete block design was used, with 4 replications. The treatments used were:

<u>2009</u>

1. Season-long use of Mycoshield (1.0 lb./acre)
2. Season-long use of Kocide 3000 (0.5 lb./acre) + Manzate Pro Stick (3.0 lbs./acre)
3. Kocide 3000 + Manzate Pro Stick up to April 8, Mycoshield April 14 through April 21

All applications were made using 100 gal./acre water; therefore Kocide 3000 was used at a rate of 0.6 g/L. Alternate rows were sprayed on each date. The 2009 spray dates are as follows:

<u>March</u> 9, 16, 19, 24, 27; <u>April</u> 2, 4, 8, 14, 16, 21

All 2009 treatments included Biofilm spreader. Alternate rows were sprayed on each date. Four row middles were used for each plot, so two alternate rows in each plot were sprayed on day one, then the other two rows were sprayed on the next spray date, etc. This design provided a 2-row buffer on either side of the center row, from which blight and russetting data were collected (see below). In addition, three short point rows with 18 trees were left completely untreated.

2010

1. Season-long use of Mycoshield (1.0 lb./acre)
2. Season-long use of Kocide 3000 (0.5 lb./acre), rotated with Mycoshield (1.0 lb./acre) (grower standard)
3. Season-long use of Kocide 3000 (0.25 lb./acre), rotated with Mycoshield (1.0 lb./acre)

All 2010 treatments included Manzate Pro Stick at 3.0 lbs./acre and Biofilm spreader and 100 gal./acre water. Alternate rows were sprayed on each date. Therefore, in 2010, rotated products were sprayed on two consecutive application dates in treatments #2 and #3, as shown below. Mycoshield alone (#1) was sprayed on each date listed. The 2010 spray dates were as follows:

March 18 & 22 (Kocide), 26 & 29 (Myco), April 2 & 5 (Kocide), 10 & 15 (Myco), 19 (Kocide)

In 2010, six row middles were used for each plot in a similar manner as described for 2009. No untreated control was used due to the complexity of the trial design and grower concern for blight damage on untreated trees.

Incidence of fire blight strikes was determined twice during each season: At the first key blight cutting period (May 7, 2009 & June 10, 2010) and just before harvest (July 13, 2009 and July 9, 2010); no cutting occurred between these dates in each year. In 2009, strikes were counted on the middle row only and in 2010, they were counted on the middle two rows. At the first evaluation, strikes were cut by the ranch foreman, and at the second evaluation, strikes were visually counted on both sides of the trees just before harvest.

To determine the effects of the bactericides on russetting, 50 fruit were picked at random from each side of the center row of each plot and assessed for the percentage total surface area of the fruit that was russetted.

Results and Discussion

2009

Measurable rainfall occurred on the following dates:

April 7-10 (0.66 in. total), May 1-3, 5 (1.04 in. total), May 27 (0.02 in.), June 4 (0.17 in.), June 22 (0.02 in.).

On May 7, there were no significant differences between treatments (Table 1). On July 13, season-long Kocide 3000 + Manzate Pro Stick (K+MPS) had significantly fewer strikes than either K+MPS followed by Mycoshield or season-long Mycoshield (Table 1). The mean number of strikes in K+MPS alone was less than half that of the other treatments, although there was only a 0.9 strike per tree difference.

No blight strikes were found on the untreated trees on the two evaluation dates, and the grower indicated that the ranch foreman removed only 3 blight strikes from these trees through the season.

The last antibiotic spray was applied April 21, and the first blight cutting was conducted May 7. Nearly all strikes from this cutting originated from flowers, and were largely a result of the

wet period in April, when bactericide sprays were being applied regularly. All products appeared to perform well, although untreated trees had virtually no blight.

Conversely, the majority of blight on the July 13 evaluation appeared to be shoot strikes, and most were quite old. It is likely that substantial infections occurred in early May and possibly on June 4. The last bactericide sprays were applied April 21, and it appears that the final K+MPS application(s) provided better protection for the shoot infections than Mycoshield.

The use of K+MPS all season had no advantage over Mycoshield alone except for the final application period. Although the cost of the K+MPS program is lower than Mycoshield, the long-term cost of developing copper resistance – loss of copper as an effective bactericide – far outweighs the short-term benefits of the lower-priced program. Therefore, when Kocide 3000 is used, it must be rotated with antibiotics.

No significant differences were found between treatments in fruit russetting, and very little russetting was present (Table 2).

2010

Measurable rainfall occurred on the following dates:

March 24 (0.07 in.); March 30-31 (0.71 in. total), April 2 (0.06 in.), April 4 (0.77 in.), April 11-13 (0.66 in. total), April 20-21 (0.92 in. total), April 27-28 (0.43 in. total), May 9-10 (0.23 in. total), May 25-27 (0.54 in. total).

Substantially more rainfall occurred in spring 2010 than spring 2009 (4.39 in. vs. 1.91 in.), and there were more days of precipitation in spring 2010 (17 vs. 11). No differences were found among treatments on either of the 2010 evaluation dates (Table 3). Although no untreated control trees were used, it would appear that all three spray programs were effective in controlling blight, including where half the rate of Kocide 3000 was used. Once again, very little russetting was found in any treatment (Table 4), showing that a blight spray program that includes K+MPS likely does not cause russetting. As previously noted, however, in 2010 there were reports of increased overall russetting in some orchards where Kocide 3000 was used, probably because of increased rainfall.

Table 1. Mean number of blight strikes per tree, 2009.

Treatment	**May 7**	**July 13**
1. Mycoshield all season	0.11 a	1.52 b
2. Kocide 3000 all season	0.27 a	0.62 c
3. Kocide 3000, then Mycoshield	0.21 a	1.73 a
P value	***0.06***	***<0.01***

Means followed by the same letter within a column are not significantly different (Tukey HSD test [May 7, $P \leq 0.05$; July 13, $P \leq 0.001$]).

Table 2. Effects of bactericide programs on fruit russetting, 2009.

Treatment	% Russetting
1. Mycoshield all season	1.06 a
2. Kocide 3000 all season	1.09 a
3. Kocide 3000, then Mycoshield	0.69 a
P value	***0.41***

Means followed by the same letter are not significantly different (Tukey HSD test, P≤0.05)

Table 3. Mean number of blight strikes per tree, 2010.

Treatment	June 10	July 9
1. Grower's standard (Kocide + Manzate / Mycoshield)	1.49 a	.91 a
2. Grower's standard with ½ rate Kocide	1.40 a	.92 a
3. Mycoshield alone	1.37 a	.88 a
P value	***0.67***	***0.88***

Means followed by the same letter within a column are not significantly different (Tukey HSD test, P≤0.05)

Table 4. Effects of bactericide programs on fruit russetting, 2010.

Treatment	% Russetting
1. Grower's standard (Kocide + Manzate / Mycoshield)	1.82 a
2. Grower's standard with half rate of Kocide	1.57 a
3. Mycoshield alone	1.54 a
P value	***0.90***

Means followed by the same letter are not significantly different (Tukey HSD test, P≤0.05)

Literature Cited:

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