Use of Kocide 3000 and a Tower Sprayer in a Fire Blight Management Program

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Abstract

Three bactericidal programs were compared for fire blight incidence and fruit russetting in a mature Bartlett pear orchard: 1) Season-long use of Mycoshield, 2) Season-long use of Kocide 3000 + Manzate Pro Stick, and 3) Kocide 3000 + Manzate Pro Stick 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. Blight incidence was evaluated on May 7 and July 13. On May 7, relatively little blight was found and there were no significant differences between treatments. In the July 13 evaluation, mostly older shoot strikes were found, and the season-long Kocide treatment had significantly fewer strikes (less than half) than the other treatments, although the mean differences were not large. 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. No significant differences in russetting were found. Also, we compared a standard air blast sprayer (100 gal./acre) with a tower sprayer (80 gal./acre) for coverage of spray cards placed at 5 and 10 ft. in tree canopies. The mean coverage by the tower sprayer was significantly greater than that by the standard sprayer at several points, especially on the upwind adjacent row. Reduced drift is likely with the tower sprayer since the spray is directed laterally and less ends up above the tree canopy.

Introduction

Antibiotics vs. Copper

Fire blight control with antibiotics continues to be a costly program. Resistance 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 fruit, but Kocide 3000 has been used on a large scale for about three years by some Sacramento district growers with good blight control and no little or no additional russetting with primarily bloom applications, although spring weather in the last three years has been relatively dry. Thus, the potential for copper phytotoxicity has been less with less copper going into solution on plant surfaces.

A variety of copper compounds are registered for use on pears. Many growers previously used copper dust, and some applications still occur. 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 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.”

The blight program for several growers from pre-bloom to 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 during the secondary bloom period. Dithane is often used for scab control, and it is labeled for blight control when used with copper; it is also believed to reduce the potential for russetting. Some growers successfully use Kocide 3000 all season long with so far no additional russetting.

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. In 2009, Dithane was not available so growers instead used Manzate and/or Penncozeb, which have the same ingredients as Dithane.

Recent US EPA re-registration and risk assessments may mean that fewer copper fungicide applications can be used per year, likely starting in 2010 (J. Adaskaveg, personal communication; EPA, 2006).

Conventional air blast vs. tower sprayer

The principal involved in traditional orchard spraying is to create enough air from the air carrier sprayer to shift and replace a majority of the air within the canopy with pesticide-laden air from the sprayer. Small or fine/medium droplets give the best coverage, as large droplets (in excess of 300 µm diameter) will likely run off the leaf onto the ground. Good coverage is critical for all bactericides. A traditional air carrier sprayer sends air upwards above the canopy, carrying with it a plume of pesticide droplets. Small or fine droplets will drift if they don’t become attached to the target leaf, insect or pear. Directed deposition is needed if pesticide is to be applied to the target zone.

With higher density pear systems that are hedged, the potential exists to improve the efficiency of pesticide application. With narrower, more upright and confined canopies, tower sprayers have the potential to reduce pesticide rates, spray volume (thereby increasing acreage covered per tank load and thereby providing an economic gain to growers), and drift. Tower sprayers have a radically different air distribution system that produces three significant benefits.

First, a conventional air-carrier orchard sprayer directs the air radially out from one central source. Many small droplets are carried through the canopy and released as "drift" in the atmosphere above the trees. An ideal tower sprayer is taller than the target canopy and produces a continuous curtain of "straight stream", uniformly spray-laden air. The top of the tower focuses the air slightly downward toward the center of the canopy as well as providing a boundary of clean air above the canopy. This boundary of clean air traps the spray-laden air into the target canopy, thus minimizing drift. Second, a tower sprayer moves the spray-laden air horizontally, parallel to the ground. The horizontal air movement provides each spray droplet the maximum opportunity to deposit on a target surface before it evaporates or lands on the soil. Third, a tower sprayer typically produces smaller size spray droplets. Because of the greatly expanded length of the air outlet on a tower sprayer, the manufacturer needs to install many more, smaller nozzles to atomize the spray. Smaller flow capacity nozzles produce smaller drops, which result in improved deposition uniformity. Careful observation of the target canopy will reveal that big drops tend to deposit on the front side of the first layer of leaves and only small drops land in the hard to reach areas. Spraying smaller drops decrease deposition on the outside edge of the tree where there is excess and increases deposition in the hard to reach areas of the fruit canopy. Control of fire blight, for which alternate row applications are made, should also be improved since upper nozzles are close to the tree tops.

Conventional axial fan air-blast sprayers produce a very unequal distribution of pesticide deposit within the tree canopy, with much higher levels of pesticide deposited in the lower portion of the tree canopy closer to the sprayer compared with the tops of trees (Cunningham and Harden 1998b, Manktelow et al. 2004, and Steinke et al. 1992.). This unequal deposition is due to the need to place sufficient pesticide for effective pest control on leaves and fruit in the top of the canopy, and the reality that spray must pass through the lower canopy to reach the upper portion of the tree. Because of this "through spraying", axial fan airblast sprayers essentially only indirectly spray the tree tops. Tower sprayers spray laterally, thus directly targeting discrete portions of the canopy and thus provide a much more uniform pesticide deposit (Cunningham and Harden 1998b, Manktelow et al. 2004, and Steinke et al. 1992).

Objective 1. Compare a season-long fire blight spray program of Mycoshield vs. Kocide 3000 vs. Kocide 3000 through petal fall and Mycoshield after petal fall on blight damage and fruit russetting.

Methods and Materials

The initial objective of this trial was to include the use of a tower sprayer vs. a standard air blast sprayer in the Mycoshield vs. Kocide 3000 comparison, but unforeseen delays occurred and the sprayer did not arrive until late April. Therefore, it was instead used in a spray coverage comparison (see below).

The trial was conducted in a mature Bartlett pear orchard at the Hansen ranch south of Walnut Grove. Orchard spacing is 16 x 10 ft. Each year, tree rows are vertically hedged down every other middle, leaving a canopy of 10-11 ft. wide and a 5-6 ft. space between the rows. The trees are topped at a height of 10-11 ft. Most rows are approximately 100 trees long.

The experiment was initially set up with four treatments (Kocide 3000 rotated with Mycoshield vs. Mycoshield alone, each with standard air blast sprayer vs. tower sprayer) and four replications. Because of the unavailability of the tower sprayer, however, changes were made so to compare current grower practices:

1. Season-long use of Mycoshield (1.0 lb./acre)
2. 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

Alternate rows were sprayed on each date. Spray dates are as follows (Kocide 3000 was sprayed on all plots on the first date):

March: 9, 16, 19, 24, 27; April: 2, 4, 8, 14, 16, 21

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. The entire experiment took up nearly the entire 23-acre block.

Incidence of fire blight strikes was determined twice during the season: May 7, which was the first key blight cutting period, and July 13, just before harvest; very little blight was cut before May 7, and no cutting occurred between these dates. Strikes were counted on the middle row only; on May 7 strikes were cut and counted by the ranch foreman, and on July 13 we counted strikes just before harvest.

To determine the effects of Kocide 3000 + Manzate Pro Stick and Mycoshield 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

Measurable rainfall occurred on the following dates:

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

Data from the two sets of season-long Mycoshield plots were combined into one treatment. On May 7, there were no significant differences between treatments (Table 1), although one set of the season-long Mycoshield treatments had significantly fewer strikes than the season-long Kocide 3000 + Manzate Pro Stick (hereafter referred to as “Kocide 3000”) treatment. Regardless, the mean number of strikes per tree on that date was low.

On July 13, Kocide 3000 followed by Mycoshield had significantly more strikes than season-long Kocide 3000 and season-long Mycoshield (Table 1). The mean number of strikes in Kocide 3000 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 little or no blight 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 Kocide 3000 application(s) provided better protection for the shoot infections than Mycoshield.

The use of Kocide 3000 all season had no advantage over Mycoshield alone except for the final application period. Although the cost of the Kocide 3000 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). Given that measurable rainfall did occur April 7-10 and bactericides were applied April 4 and 8, the Kocide 3000 treatment was likely subjected to conditions that would have produced additional russetting from older Kocide formulations (e.g., Kocide DF).

Table 1. Mean number of blight strikes per tree.

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

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.

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

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

<u>Objective 2</u>.Compare the use of a tower sprayer with a standard orchard sprayer in spray coverage, as determined by water-sensitive spray cards.

Methods and Materials

A Turbo-Mist tower sprayer (Slimline Manufacturing, (FMC 352, PTO-driven, 600gal. 150 psi) and a standard orchard sprayer (FMC 352, PTO-driven, 500gal., 175 psi) were used to compare spray coverage in the same hedged Bartlett pear orchard (see above). Water was sprayed in two different tests (May 5 and May 18). Water-sensitive spray cards 2 in. wide x 3 in. tall were placed at 5 and 10 ft. on PVC poles, which were secured upright in the tree canopy.

On both dates, the tractor was driven down a single row, spraying both left and right (east and west). A pass was made with the standard orchard sprayer, the foliage was allowed to dry, the spray cards were removed, and then new spray cards were attached at the same locations and orientation. Another pass was made using the tower sprayer and cards were removed when dry. The standard sprayer was operated at 100 gal./acre and the tower sprayer was set to 80 gal./acre. The same tractor gear settings and RPM were used for both sprayers.

On <u>May 5</u>, four poles were placed at five points down the two adjacent rows to the east and the two adjacent rows to the west (Fig. 1). The poles at each point were placed as follows:

1) EAST second row over from sprayed middle, pole placed near inner canopy edge (on the edge closer to sprayer)
2) EAST adjacent row, pole placed just beyond the trunk center
3) WEST adjacent row, pole placed just beyond the trunk center
4) WEST second row over from sprayed middle, pole placed near inner canopy edge (on the edge closer to sprayer)

Fig. 1. Location of poles with spray cards on May 5. One pass made with standard sprayer, followed by tower sprayers after drying.

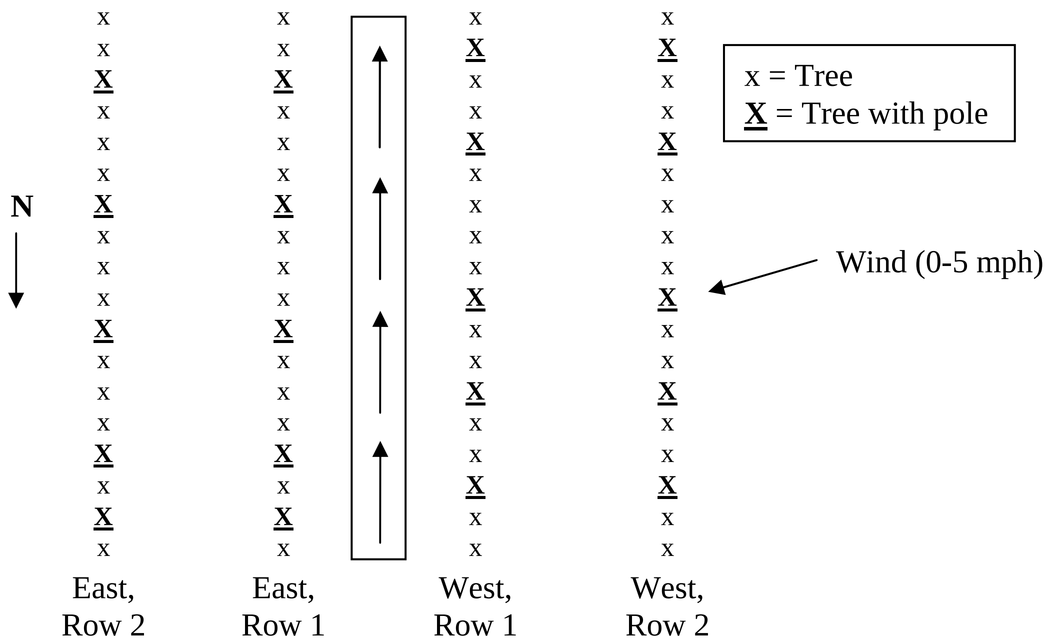
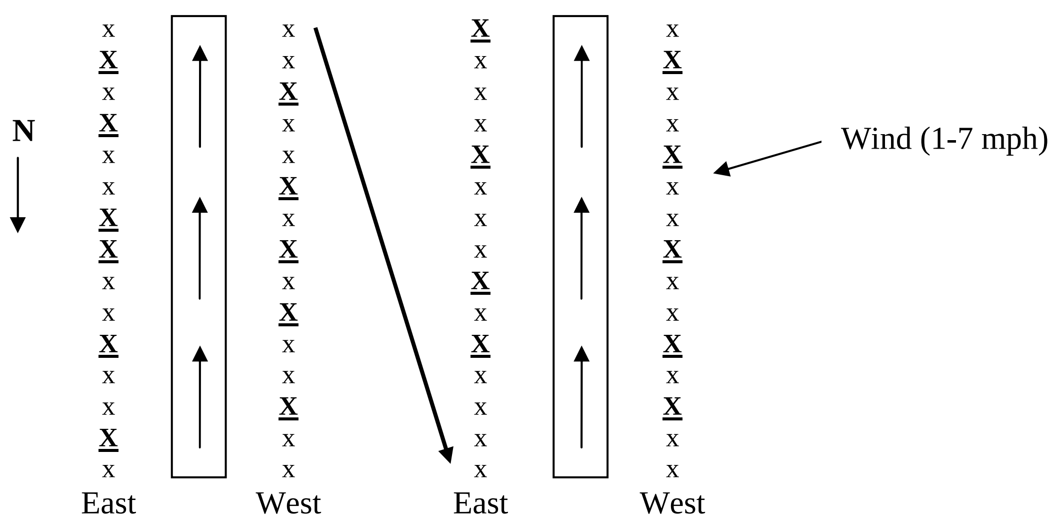


Fig. 2. Location of poles with spray cards on May 18. One pass made with standard sprayer, followed by tower sprayers after drying. (One row only, split in two to fit on page.)



On May 18, two poles were placed at 10 points down each of two rows and the sprayer was driven between the rows (Fig. 2). The poles at each point in this study were placed in the center of each tree as follows: 1) EAST adjacent row, 2) WEST adjacent row

On both dates, poles were placed in trees that were fully canopied and uniform. Wind speed at the time of spraying on May 5 was <1 mph at chest height and up to 5 mph above the canopy. On May 18 wind speed at chest height at the time of spraying was 1-2 mph and up to 7-8 mph above the canopy.

Results and Discussion

On May 5, coverage by the tower sprayer on the second row to the west (upwind) was significantly greater at both 5 and 10 ft. (Table 3). Coverage on the adjacent row to the east at 5 ft. was also significantly greater with the tower sprayer. The mean coverage by the tower sprayer was slightly greater than the standard sprayer on all but one of the other spray card locations.

On May 18, coverage by the tower sprayer was significantly greater than that of the standard sprayer at 5 ft. height on the west (upwind) side (Table 4).

There can be substantial variability in tree architecture where spray cards were placed. However, it seems clear that spray coverage by the tower sprayer, even at only 80 gal./acre, was at least as good as coverage by the standard sprayer at 100 gal./acre. This trial was conducted after alternate-row blight sprays had ended, so more foliage was present. Nonetheless, there are indications that greater coverage, especially in the upwind direction of the second row over, may be possible with the tower sprayer. Also, reduced spray volume would enable faster coverage of the orchard. Finally, reduced drift is likely with the tower sprayer since the spray is directed laterally and less ends up above the tree canopy.

Table 3. Percent coverage of spray cards, May 5.

		East, Row 2		East, Row 1			West, Row 1		West, Row 2	
10 ft.	Std.	9.61	**a**	9.67	**a**		0.61	**a**	0.00	**b**
	Tower	7.48	**a**	12.78	**a**		4.24	**a**	9.39	**a**
5 ft.	Std.	1.17	**a**	28.10	**b**		2.69	**a**	0.06	**b**
	Tower	17.38	**a**	57.67	**a**		14.84	**a**	6.72	**a**

Means with the same letter in each column & height are not significantly different (Tukey HSD test, P≤0.05).

Table 4. Percent coverage of spray cards, May 18.

		East		West	
10 ft.	Std.	11.9	**a**	14.0	**a**
	Tower	21.2	**a**	8.3	**a**
5 ft.	Std.	67.3	**a**	32.3	**b**
	Tower	72.2	**a**	65.1	**a**

Means with the same letter in each column & height are not significantly different (Tukey HSD test, P≤0.05).

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