NYS IPM PROGRAM
Agricultural IPM Project Reports

1. Title: Importance of Early-Spring-Pruning Copper Sprays and Training Systems in Managing Bacterial Canker of Sweet Cherry

2. Project Leader(s): Juliet Carroll[1], Terence Robinson[2], and Thomas Burr[3]. [1]NYS IPM Program, [2]Horticultural Sciences, and [3]Plant Pathology, NYSAES, Cornell University, Geneva, NY 14456

3. Cooperator(s): Steve Hoying. Lake Ontario Fruit Program, CCE, Newark, NY 14568 (current address: Horticultural Sciences, NYSAES, Cornell University, Highland, NY 12528)

4. Abstract:
Bacterial canker is a serious disease of sweet cherry that limits orchard life and tree productivity. New York tree fruit growers ranked the need for research on bacterial canker in the top ten. Currently, copper sprays are used to manage the disease, however, the effectiveness of copper sprays in protecting pruning cuts is unknown. Leaving a 15-cm-long pruning stub to manage the lethal canker phase of the disease has shown promise. The occurrence of copper-resistant bacteria and negative impacts of copper on soils underscore the need for research. We studied the effectiveness of spring copper sprays and the pruning stub in preventing canker infection. Neither copper nor pruning stubs prevented infection of inoculated and uninoculated pruning cuts. Six training systems were assessed and ranked in order of increasing bacterial canker incidence as follows: Perpendicular V, Zahn Vertical Axis, Marchant, Vogel Slender Spindle, Modified Central Leader, and Spanish Bush. Five cultivars in each training system ranked in order of increasing bacterial canker incidence as follows: Sweetheart, Lapins, Tehranivee, Hedelfingen, and Regina. Our results suggest that applying copper sprays may not improve control of the canker phase of this disease. The pruning stubs appeared to impact the progression of the disease by distancing infections from the main trunk. The Perpendicular V and Zahn Vertical Axis orchard training systems showed the lowest vulnerability to canker infections. Further research is needed to determine the pruning strategy's effectiveness on long term management of the disease.

5. Background and justification:

Apple growers have diversified production into sweet cherry in order to realize better markets. In 2004, NY farmers grew 700 acres of sweet cherries valued at 1.2 million dollars. Terence Robinson and Steve Hoying are investigating new training systems to assist growers in optimizing sweet cherry orchard systems. In order to manage bacterial canker in the planting system research trial, four copper applications are being made (two in spring and two in late summer) and 15-cm-long pruning stubs are being left to prevent scaffold and trunk infections.

Bacterial canker is perhaps the most serious disease of sweet cherry, but it also affects tart cherry, though less severely. This destructive disease can reduce yield and vigor and ultimately kill systemically infected and cankered trees. Infections include "dead bud", blossom blast, leaf spots, and cankers. When pruning cuts made flush to the main trunk or scaffold branches become infected, cankering and tree death can result. Bacteria overwinter in bark tissue at canker margins, in apparently healthy buds, and/or systemically in the vascular system. The

disease is particularly difficult to manage on sites wherever cool, humid and moist conditions prevail during the growing season. Infections are often linked to winter injury and frost damage. The bacterial pathogens (*Pseudomonas syringae* pv. *syringae* (Pss) and *P. s.* pv. *morsprunorum*) exist as epiphytes on leaves, flowers, and branches and increase in number and prevalence during cool, humid spring and autumn weather.

Current management of this disease on sweet cherry relies on copper sprays during the growing season to keep epiphytic populations in check. According to the Cornell Pest Management Guidelines, the optimum timing and effectiveness of copper sprays for bacterial canker is not known under New York conditions. In the planting systems trial, Robinson and Hoying have timed the first spray at bud swell just prior to pruning and the second immediately after pruning in an effort to protect pruning cuts from infection.

Bacterial canker biology and management ranks 7th for the tree fruit IPM Stakeholder Research Priorities listed in the NYS IPM RFP. We propose to study the biology and management of bacterial canker on sweet cherry, focusing on the spring pre- and post-pruning copper sprays, the 15-cm-long branch stubs, and the different training systems. Intended outcomes include optimal timing and elimination of copper sprays, innovative pruning practices, and best training systems to minimize bacterial canker. Anticipated impacts include reduced selection for copper-resistant bacterial strains and mitigation of the copper load on soils.

6. Objectives:

1. Determine the importance of copper sprays in protecting spring pruning wounds from infection with bacterial canker.
2. Determine the fate of bacterial inoculations on 6-inch pruning stubs.
3. Survey the sweet cherry planting systems trial to ascertain levels of bacterial canker in each training system.
4. Project evaluation.

7. Procedures:

1. <u>Determine the impact of copper sprays on protecting spring pruning wounds from infection with bacterial canker.</u> This objective was carried out on the cultivar Hedelfingen trained to the Zahn Vertical Axis System in three replicate blocks, 15 trees per block. Trees were sprayed on April 8 and 11 with 9.3 lb/A and 8.5 lb/A of Cuprofix Disperss, respectively, immediately before and immediately after pruning. On each tree, two lateral branches were flagged for pruning and one branch was covered with plastic in the pruning zone immediately before the "pre-pruning" copper spray to prevent treatment with copper (untreated) and the other was left uncovered (treated). Plastic was removed from the untreated branches as soon as possible following treatment, and pruning proceeded. Untreated branches were pruned with separate tools to prevent contamination with copper residue. Pruning stubs on the untreated branches were covered with plastic bags to prevent treatment with the "post-pruning" copper spray and the bags removed as soon as possible after spraying. All stubs were rated for gummosis, canker and extent of canker on May 4, May 22, June 9, Aug 10, and Sept 11. Differences in gummosis, canker and extent of canker on treated vs. untreated pruning stubs were compared.
2. <u>Determine the fate of bacterial inoculations on 15-cm pruning stubs.</u> This objective was carried out on 16 cv Hedelfingen trees trained to the Zahn Vertical Axis System in three blocks, (four trees in one block and six in the other two) in a location separate from the copper exclusion

experiment described above. Two branches on each tree were flagged for pruning and either untreated or treated with copper as described above. On Apr 10 and 11, immediately following pruning, the cut end of all stubs was inoculated with *Pseudomonas syringae* pv. *syringae* (Pss) at 3.4 x 10^8 cfu/ml. All stubs were covered with plastic bags following inoculation. Immediately before application of the post-pruning copper spray, the bags were removed from the stubs to allow treatment with copper post-inoculation. All pruning stubs were rated for gummosis, canker and extent of canker on Apr 28, May 17, May 24, June 12, Aug 4, and Sept 5. Isolations from stubs to recover Pss were made on Apr 28 and May 24. Pss was identified by development of green fluorescent pigment on Pseudomonas Agar F, negative cytochrome oxidase test, and positive pathogenicity test on green cherry fruit. On Aug 10, treated and untreated inoculated branch stubs were cut from half of the trees in each row. In the laboratory, bark was removed and the internal extent of discoloration measured. Differences between treated vs. untreated pruning stubs in gummosis, canker, extent of canker and recovery of Pss were compared.

3. Survey the sweet cherry planting systems trial to ascertain level of bacterial canker in each training system. Surveys for bacterial canker on trees were carried out in the three replicate blocks of the sweet cherry planting systems trial, each block containing 3 rows approximately 100 ft long of each of the following tree-training systems, Modified Central Leader (7 trees/112 ft row), Spanish Bush (11 trees/110 ft row), Marchant (14 trees/112 ft row), Perpendicular V System (16 trees/96 ft row), Vogel Slender Spindle (12 trees/96 ft row), and Zahn Vertical Axis (16 trees/96 ft row). There were five cultivars in each training system block, including Hedelfingen (ca. 72 trees/block), Lapins (ca. 50 trees/bock), Regina (ca. 25 trees/block), Sweetheart (ca. 53 trees/block), and Tehranivee (ca. 24 trees/block). On November 29 and 30, after leaf fall was complete, trees were rated for bacterial canker on a severity scale of 0-9 based on the number of branches with cankers and the number of cankers per branch, as shown in Table 1 below. Planting system and cultivar differences in canker incidence and severity were compared.

Table 1. Bacterial canker visual rating based on number of branches with canker (incidence) and number of cankers per infected branch (severity) on a scale of 0 (no cankers) to 9 (high incidence and severity of cankers).

Rating Scheme for Canker Severity		
Severity Rating	**# Branches with Canker**	**# Cankers per Branch**
0	0	0
1	1	1
2	1	2 to 3
3	1	4 or more
4	2 to 3	1
5	2 to 3	2 to 3
6	2 to 3	4 or more
7	4 or more	1
8	4 or more	2 to 3
9	4 or more	4 or more

4. Project evaluation. The project was evaluated by determining the relative importance of (1) copper sprays, (2) the 15-cm pruning stub treatment, and (3) the training systems as IPM tactics for bacterial canker. Measures of project success included:

- The ability of growers to optimally time or eliminate copper sprays at bud swell.
- Use a 15-cm stub during lateral branch pruning to reduce canker risk.
- Identification of a training system(s) least prone to bacterial canker.

8. Results and discussion:

1. Determine the importance of copper sprays in protecting spring pruning wounds from infection with bacterial canker. Copper sprays before and after pruning did not significantly reduce gummosis (Fig 1A), canker (sunken bark) incidence, or proximal extent of sunken bark (Fig 1B) on pruning stubs compared to untreated pruning stubs. Ratings of canker symptoms (sunken bark) may reflect normal senescence of cambial tissues following pruning or infection/colonization by fungi. In August and September as extent of canker increased on stubs, ratings of sunken bark extending ≤ 1 cm and ≤ 2 cm, respectively, and stubs with fungal pycnidial or ascomatal stroma (two and six, respectively) were not included in counts of bacterial canker comparisons between copper treated and untreated stubs in order to distinguish symptoms of senescent tissue from bacterial canker. Even when correcting for these factors, no significant control of bacterial canker infection of the stubs was found, with 74% and 81% of copper-sprayed branch stubs showing symptoms of bacterial canker on August 9 and September 10, respectively, which translated into only 12% and 7% control. These results suggest copper sprays offer little protection to pruning wounds from infection by Pss.

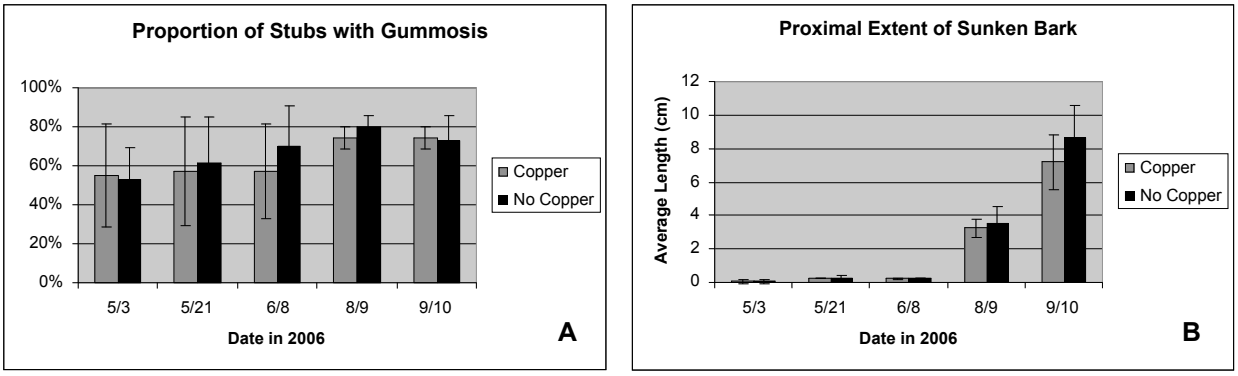


Figure 1. Comparison of copper-treated and untreated pruning stubs for gummosis (A), a symptom of bacterial canker, and extent of sunken bark from the cut end of the pruning stub towards the tree trunk (B). Bars show standard deviation.

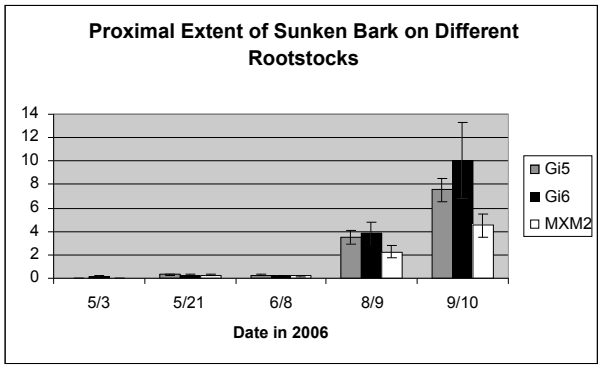


Figure 2. Comparison of the extent of sunken bark on pruning stubs on Hedelfingen trees grafted to three different rootstocks. Bars show standard deviation.

Each replicate block of Hedelfingen in the study consisted of trees grafted to different rootstocks, allowing comparison of the progression of bacterial canker on scion wood grafted to three different rootstocks, Gisela 5 (Gi5), Gisela 6 (Gi6), and MxM2. Although the average incidence of canker on pruning stubs for the trees grafted to each of these rootstocks was similar (data not shown), the extent of sunken bark was greatest on Gi6 and least on MxM2 (Fig 2).

2. Determine the fate of bacterial inoculations on 6-inch pruning stubs. Pss was recovered from 89% of stub cuts and from 94% of flush cuts, indicating no direct benefit from pruning stubs in preventing Pss infection. Copper treatment failed to prevent infection by Pss and Pss was

recovered from 95% of copper treated and 88% of untreated pruning wounds. Copper treatment may stimulate gummosis on inoculated stub cuts as compared to untreated stub cuts (Fig 3A), though not significantly. Treatment with copper did not significantly decrease the extent of sunken bark on stubs as the season progressed (Fig 3B). On inoculated stubs the extent of canker was greater than on uninoculated stubs (compare Figs 1B and 3B). The proportion of stubs with gummosis and canker was greater on inoculated vs. uninoculated stubs (90% vs. 65% and 97% vs. 79%, respectively) and may reflect a higher proportion of stubs infected with Pss.

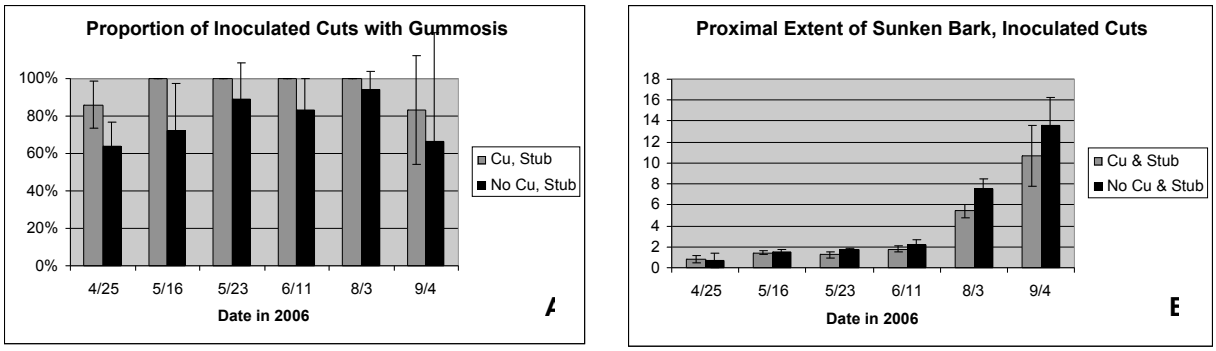


Figure 3. Comparison of Pss-inoculated copper-treated and untreated pruning stubs for gummosis (A), a symptom of bacterial canker, and extent of sunken bark from the cut end of the pruning stub towards the tree trunk (B). Bars show standard deviation.

The internal extent of discoloration on pruning stubs (Table 2) was not reduced by copper treatment. Though the extent of discoloration is less for flush cuts, this may be an artifact of the smaller diameter of the lateral branches that were pruned flush. When branch diameter was factored in to the extent of discoloration for each branch stub and the average taken these differences disappeared and the flush cuts tended to have greater extent of discoloration per branch diameter.

Table 2. The extent of discoloration associated with bacterial infection on stub and flush cuts, measured in the laboratory after removing bark from branch stub sections cut from trees. Avg Diam is the average diameter (of the cut surface (stub or flush).

Dissected Inoculated Branches				
Pruning	**Treatment**	**Avg Extent Discoloration**	**Avg. Diam**	**Avg Extent/Diam**
Stub	Copper	14.7 cm	2.4 cm	6.1
Stub	No Copper	13.2 cm	2.5 cm	6.0
Flush	Copper	8.2 cm	1.3 cm	8.9
Flush	No Copper	8.3 cm	1.2 cm	8.1

3. <u>Survey the sweet cherry planting systems trial to ascertain levels of bacterial canker in each training system</u>. All six training systems had evidence of cankers and ranked in order of increasing incidence of canker infection, as follows: Perpendicular V (least vulnerable), Zahn Vertical Axis, Marchant, Vogel Slender Spindle, Modified Central Leader, and Spanish Bush (most vulnerable) (Fig 4).

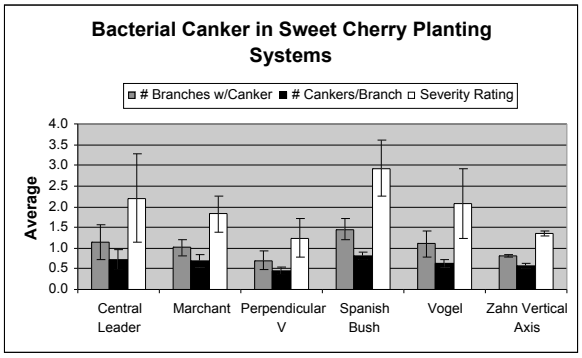
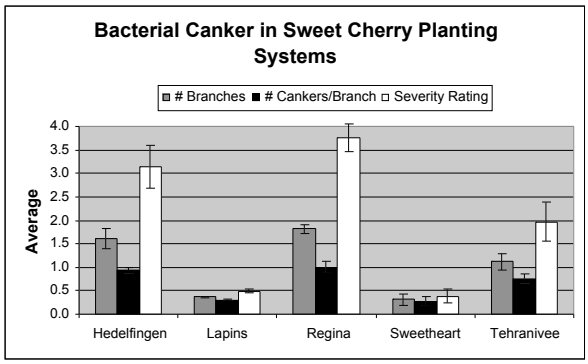


Figure 4. Comparison of six different tree-training systems for bacterial canker incidence and severity. Rating scheme shown in Table 1. Bars show standard deviation.



All five cultivars in each training system block showed evidence of bacterial canker infection. However, Sweetheart and Lapins were least prone to canker infections followed by Tehranivee, Hedelfingen, and Regina (Fig 5).

Figure 5. Comparison of five different sweet cherry cultivars for bacterial canker incidence and severity. Rating scheme shown in Table 1. Bars show standard deviation.

4. Project evaluation.

- *The ability of growers to optimally time or eliminate copper sprays at bud swell*. Copper sprays applied in spring are timed to prevent phytotoxicity to cherry leaves and to reduce the epiphytic populations of Pss. From this limited study it might be concluded that growers could eliminate spring copper sprays because they provide no benefit in protecting pruning cuts. Further research to more conclusively answer this question as it relates not only to the canker phase of the disease but to the other phases of the disease is needed. As the season progressed the extent of canker on the pruning stubs appeared to be less on those treated with copper in both the uninoculated and inoculated experiments. We have submitted a Hatch preproposal to continue this research, recognizing that the etiology of canker diseases is best studied over multiple years.
- *Use a 15-cm stub during lateral branch pruning to reduce canker risk*. The pruning stub did not directly prevent infection by Pss. Pruning stubs may impact bacterial canker disease primarily by 'distancing' the main trunk from pathogen invasion. Adoption of the pruning stub technique by growers will involve training orchard managers and pruning crews to leave the stubs during spring pruning. This technique may prove difficult to adopt because leaving a pruning stub is normally considered a poor pruning practice from the standpoint of tree health.
- *Identification of a training system(s) least prone to bacterial canker*. The two training systems least prone to bacterial canker were Perpendicular V and Zahn Vertical Axis. Growers would likely adopt the Vertical Axis training system because it requires minimal pruning and thus less labor during establishment and has been the most profitable training system during the 6 years of the sweet cherry training systems trial of Robinson and Hoying.

9. Project location(s): The findings of this research have application in New York in the Lake Ontario Plains and the Hudson Valley regions and wherever sweet cherries are grown. In 2004, 700 acres of sweet cherries were grown in NY. Nationally, the results could be applied in regions with similar climate.

10. Samples of resources developed: A brief report was prepared for the Sweet Cherry Field Day at NYSAES, held in July 2006. Excerpts were published in a booklet handed out to growers at the workshop (paper copy attached). The work was also presented and published, as follows:

Carroll, Robinson, and Burr. 2006. Effect of early-spring-pruning and copper sprays for managing bacterial canker of sweet cherry. Northeast Division of APS abstract. (*in press*)

Carroll, Robinson, and Burr. 2006. Importance of early-spring-pruning copper sprays in managing bacterial canker of sweet cherry. Proc. Cumberland-Shenandoah Fruit Workers Conf. (*in press*)