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Evaluation of Selected Bactericides for the Control of Fire Blight on Crabapple[1]

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Abstract

Agrimycin 17 21.2W (streptomycin sulfate), Aliette WDG (fosetyl-Al), Kocide 101 77W (copper hydroxide), Phyton 27 (copper sulfate pentahydrate), and the experimental fungicide fluazinam 500F were evaluated for the control of fire blight (*Erwinia amylovora*) on field-grown crabapple. A block of bare-root flowering crabapple (*Malus* sp.) 'Snowdrift' was established in 1995, and the study was conducted in 1996, 1997, and 1998 at the Brewton Experiment Field in Brewton, AL (USDA Plant Hardiness Zone 8a). In all three years, streptomycin sulfate was the only product that significantly reduced the severity of fire blight. Typically, damage on the Agrimycin 17-treated trees was unobtrusive and restricted to the death of a few scattered bloom clusters (strikes). In two of three years, fire blight damage levels on the Kocide 101-treated trees were intermediate between those sprayed with streptomycin sulfate and the unsprayed control. Although intermediate disease control was also obtained in 1996 with Phyton 27, this fungicide/bactericide failed to significantly reduce disease severity in 1997 and 1998 as compared to the unsprayed control. In all three years, no significant reduction in the severity of fire blight was obtained with Aliette WDG or fluazinam 500F.

Index words: *Erwinia amylovora*, Agrimycin 17, streptomycin sulfate, Kocide 101, copper hydroxide, Aliette WDG, fosetyl-Al, Phyton 27, copper sulfate pentahydate, fluazinam, chemical control, disease control.

Species used in this study: Crabapple (*Malus* sp.) 'Snowdrift'.

Significance to the Nursery Industry

Although fire blight is a destructive disease nationwide on many trees and shrubs in the apple sub-family, information concerning the efficacy of bactericides for the control of this disease on ornamental crops is not available. Over the three-year test period, Agrimycin 17 21.2 W (streptomycin sulfate) gave consistent disease control on the fire blight-susceptible crabapple cultivar 'Snowdrift'. Typically, fire blight damage on the Agrimycin 17-treated trees was minor. In contrast, Aliette WDG, Phyton 27, and a dormant application of Kocide 101 77W, which are all registered for fire blight control on woody ornamentals, failed to protect crabapple from this disease. Also, the experimental fungicide fluazinam 500F demonstrated no activity against fire blight.

Introduction

Fire blight, which is incited by the bacterium *Erwinia amylovora* (Burrill) Winslow *et al*., is a widespread and damaging disease in the orchard, nursery, and landscape in plantings of many of the members of the apple sub-family (*Pomodidae*) (11). While pome fruit such as apple (*Malus* sp.) and pear (*Pyrus communis* L.) are recognized as the most commercially important hosts of fire blight, destructive disease outbreaks are common on ornamental shrubs and small flowering trees (11). In Alabama, selected cultivars of crabapple (*Malus* sp.), flowering pear (*Pyrus callereya* Decne.), Indian hawthorn (*Rhapiolepsis umbellata* (Thunb.) Mak.), and cotoneaster (*Cotoneaster* spp.), as well as loquat (*Eriobotrya japonica* (Thunb.) Lindl.), are the most common ornamental hosts of fire blight (2, 3, 11). In addition, selections of photinia (*Photinia* x *fraseri* Dress, *P. serrulata* Lindl., and *P. glabra* (Thunb.) Maxim), flowering quince (*Chaenomeles speciosa* (Sweet) Nak.), hawthorn (*Crataegus* spp.), and pyracantha (*Pyracantha coccinea* Roem.) also may be damaged by fire blight (5, 11). Over a period of several years, the above shrubs and trees are often badly disfigured and may sometimes be killed by repeated outbreaks of fire blight (11).

Although the establishment of fire blight-resistant cultivars is the preferred method of controlling this disease (2, 3, 5, 11), trees and shrubs, which are susceptible to this disease, are a common feature in many Alabama landscapes. Fire blight-susceptible shrubs and trees are more readily available from retail outlets across the state than disease resistant selections. In addition, a number of container and field nurseries still have fire blight-susceptible shrubs and trees on their production schedules. Consequently, protective bactericide treatments are often needed in the nursery and landscape to maintain the health and beauty of shrubs and trees that are vulnerable to fire blight.

The antibiotic Agrimycin 17 21.2W (streptomycin sulfate) is widely used to control the blossom blight phase of fire blight in commercial plantings of apple and pear (11). Concerns have been raised about the potential for control failures due to antibiotic resistance in plantings where Agrimycin 17 21.2W and other streptomycin sulfate-containing bactericides were routinely used on apple (7, 11). Several copper-containing pesticides such as Kocide 101 77W (copper hydroxide) and Phyton 27 (copper sulfate pentahydrate) are registered for the control of fire blight but are not considered as efficacious in controlling this disease as Agrimycin 17 21.2W (11). When applied to the foliage, copper bactericides/fungicides can cause a spotting and yellowing of the leaves, as well as premature leaf shed on some plants, particularly apple and crabapple (Hagan, personal observation, 11). Consequently, use of some potentially phytotoxic copper bacte-

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ricides/fungicides for the control of fire blight has been limited to dormant treatments prior to bud break.

Aliette WDG (fosetyl-Al), a fungicide widely used to control Pythium and Phytophthora-incited diseases on a variety of ornamental, vegetable, and fruit crops is also registered for the suppression of fire blight. In France, Paulin *et al.* (8) demonstrated that this fungicide significantly reduced the incidence of fireblight on orchard-grown apple. In a 1992 Indiana study, two or three applications of 2.4 and 4.7 g a.i./liter (2.5 and 5.0 lb/100 gal) rates of Aliette WDG were as effective in controlling fire blight on 'Golden Delicious' apple as was streptomycin sulfate (10). However, no reductions in the percentage of blighted blooms or canker elongation on Aliette-treated apples was noted by Pecknold (9) or Hinkey *et al.* (4), respectively. In addition, Chase (1) showed that strains of the *E. amylovora* were less sensitive in vitro to Aliette WDG than other phytopathogenic bacteria. Also, Aliette WDG failed to control *E. chrysanthemi*-incited leaf spot on philodendron (1). Finally, data concerning the efficacy of Aliette WDG for the suppression of fire blight on shrubs and trees is not available.

Due to the lack of information concerning bactericide efficacy against fire blight, a 3-year trial was conducted in a simulated landscape planting of 'Snowdrift' crabapple to assess the efficacy of Agrimycin 17 21.2W, Kocide 101 77W, Phyton 27, Aliette WDG, and the fungicide fluazinam 500F, which was thought to have antibacterial activity, for the control of this disease.

Material and Methods

Before planting, the soil fertility and pH of a Benndale (A) fine sandy loam soil was adjusted to recommended levels based on the results of a soil fertility assay done by the Auburn University Soil Testing Laboratory. In March 1995, bare-root crabapple 'Snowdrift' were established on 9.2 m (10 ft) centers in rows 9.2 m (10 ft) apart at the Brewton Experiment Field in Brewton, AL (USDA Plant Hardiness Zone 8a), which is located approximately 83 km (50 miles) northeast of Pensacola, FL.

The experimental design was a randomized complete block with 6 single tree replications. At planting, a drip irrigation system was installed, and the trees were watered as needed. After planting, the beds were mulched with pine bark. Twice each spring, 16N–4P_2O_5–8 K_2O fertilizer at a rate of 55 kg/ha (50 lb/A) was broadcast down each row of trees. For preemergent weed control, directed applications of 0.9 kg/ha (1 lb/A) of Gallery™ DF and 4.6 liters/ha (2 qt/A) of Surflan™ T/O were broadcast early each spring over the mulched area around the trees. Hand weeding and spot applications of recommended rates of the herbicides Roundup™ or 912 Herbicide™ 6S (monosodium acid methanearsonate [MSMA]) were made to control escape weeds.

Agrimycin 17™ 21.2W at 0.13 g a.i./liter (0.5 lb/100 gal) [Syngenta, Greensboro, NC], Phyton 27™ at 0.24 g a.i./liter (12.5 fl oz/100 gal) [Source Technology Biologicals, Edina, MN], Aliette WDG™ at 1.9 g a.i./liter (2.0 lb/100 gal) [Aventis Crop Science, Raleigh, NC], and fluazinam 500F [Syngenta, Greensboro, NC] at 1.2 g a.i./liter (12.0 fl oz/100 gal) were applied to the foliage to run-off using an ATV-mounted electric sprayer with one nozzle on a hand-held boom. In each year, the dormant application of copper hydroxide (Kocide 101™ 77W) at 14.4 g a.i./liter (12 lb/100 gal) [Griffin L.L.C., Valdosta, GA] was made at the green tip growth stage on March 1, 1996; February 28, 1997; and March 3, 1998. All other treatments were applied at 7-day intervals from March 14 until May 14, 1996; March 26 to May 19, 1997; and April 1 to May 24, 1998. An unsprayed control was also included. Fire blight severity was rated on May 29, 1996; May 19, 1997; and May 9, 1998, on a scale of 1 to 5 where 1 = no disease, 2 = one to a few flower clusters or shoot tips diseased, 3 = numerous blighted shoots with a few large branches killed, 4 = major portion of tree killed, and 5 = tree killed. Significance of bactericide treatment effects on fire blight was tested by analysis of variance, and means were compared with Fisher's protected least significance difference (LSD) test with a level of significance at $P = 0.05$.

Results and Discussion

In all three years, damaging outbreaks of fire blight were recorded on the unsprayed or control crabapples. As indicated by disease ratings of 2.3 to 2.6, symptoms observed in each year on the unsprayed trees included noticeable blighting of the blossom clusters and dieback of the shoot tips, as well as the occasional death of one or more scaffold limbs (Table 1). During this three-year study, none of the treated or unsprayed control trees succumbed to fire blight.

In 1996, Agrimycin 17 21.2 W was the only treatment to significantly reduce the level of fire blight damage compared to the unsprayed crabapples (Table 1). Fire blight damage ratings for the trees sprayed with Phyton 27 or Kocide 101 77W did not differ significantly from those obtained with Agrimycin 17 21.2W. In addition, the disease ratings for the crabapples treated with both of the above copper bactericides were significantly below those for the Aliette WDG and fluazinam 500F-treated trees but not the unsprayed controls. Fire blight damage ratings for the trees sprayed with fluazinam 500F and Aliette WDG were similar to those recorded for the unsprayed crabapples. No symptoms of copper or streptomycin sulfate phytotoxicity were associated with the use of Phyton 27 or Agrimycin 17 21.2W, respectively.

In 1997, Agrimycin 17 21.2W significantly reduced fire blight damage below the levels noted for the unsprayed

Table 1. Selected bactericides compared for the control of fire blight on 'Snowdrift' crabapple.

Treatment	Application rate g a.i./liter	Fire blight severity[z] 1996	1997	1998
Agrimycin 17 21.2W[y]	0.1	1.2d[x]	1.5b	1.5c
fluazinam 500F	1.2	2.7ab	2.4a	2.3ab
Aliette WDG	1.9	2.8a	2.7a	2.9a
Phyton 27	0.2	1.9bcd	2.8a	2.5ab
Kocide 101 77W	14.4	1.6cd	2.3a	1.8bc
Unsprayed control	—	2.3abc	2.6a	2.4ab
LSD (P = 0.05)	—	0.8	0.6	0.7

[z]Fire blight severity was rated on a scale of 1 to 5 where 1 = no disease, 2 = one to a few flower clusters or shoots diseased, 3 = numerous blighted shoots with a few large branches killed, 4 = major portion of tree killed, and 5 = tree dead.

[y]Kocide 101 was applied as a dormant spray before the green tip growth stage, while the other treatments were applied at 7-day intervals from March 14 to May 14, 1996; March 26 to May 19, 1997; and from April 1 to May 24, 1998.

[x]Mean separation within columns was tested according to Fisher's Protected Least Significance (LSD) test (P = 0.05).

crabapples (Table 1). Kocide 101 77W, Phyton 27, Aliette WDG, and fluazinam 500F gave significantly poorer disease control than did Agrimycin 17 21.2W. In addition, fire blight severity on the trees sprayed with Kocide 101 77W, Phyton 27, Aliette WDG, and fluazinam 500F was similar to the results recorded on the unsprayed controls. None of the bactericides/fungicides evaluated were phytotoxic to crabapple.

In 1998, Agrimycin 17 21.2W significantly reduced the severity of fire blight when compared with the unsprayed control for the third consecutive year (Table 1). Although Kocide 101 77W gave better disease control than Aliette WDG, Phyton 27, and fluazinam 500F, the severity of fire blight did not significantly differ from disease levels on the unsprayed crabapples. In addition, Phyton 27, Aliette WDG, and fluazinam 500F again failed to significantly reduce disease severity when compared to the unsprayed control. On all trees except for those treated with Agrimycin 17 21.2W and Kocide 101 77W, noticeable blossom blight, shoot dieback, and death of a few scaffold limbs was observed. Again, the copper bactericide/fungicide Phyton 27 and Agrimycin 17 21.2W did not damage the foliage of crabapple.

Although none of the five bactericides/fungicides completely prevented the development of fire blight on crabapple, significant differences in the level of disease control were noted in each year among the treatments evaluated. As noted in previous studies on apple (4, 7, 9), Agrimycin 17 21.2W demonstrated good activity against fire blight on crabapple. In all three years, this bactericide was the only treatment that consistently reduced the disease severity in all three years compared with the unsprayed control. Damage on the Agrimycin 17-treated crabapples, which was limited to the blighting of a few, scattered blossom clusters, was unobtrusive and did not have a detrimental impact on tree health. Reductions in the number of blossom clusters blighted or strikes seen in this study were similar to those previously reported on apple (4, 7, 9).

In two of three years, the fire blight ratings for trees treated with the dormant application of Kocide 101 77W did not differ significantly from those recorded for the Agrimycin 17-treated crabapples. However, no significant differences in disease ratings were ever noted between the Kocide 101-treated crabapples and the unsprayed controls. The inconsistent results with Kocide 101 77W confirm the observation by Van der Zwet and Beer (11) that copper bactericides/fungicides have limited activity against fire blight.

When compared with disease levels on the unsprayed control, Phyton 27 failed to significantly reduce the severity of fire blight. Disease severity on the Phyton 27-treated crabapples was similar only in 1996 to that recorded on the trees treated with Agrimycin 17 21.2W, but did not differ from the unsprayed control. The experimental fungicide fluazinam 500F also demonstrated little if any efficacy for the control of fire blight on rabapple.

Previous studies on apple have shown that Aliette often provided inconsistent control of fire blight (4, 8, 9, 10). In this study, a total of 10 applications of Aliette WDG consistently failed to significantly reduce the severity of fire blight on crabapple. Differences in the level of disease control observed here between Agrimycin 17 21.2W and Aliette WDG mirrored those previously reported by Pecknold (9) and Hinkey *et al.* (4).

When compared to Phyton 27, Aliette WDG, fluazinam 500F and to a lesser extent the dormant treatment of Kocide 101 77W, Agrimycin 17 21.2W provided the best and most consistent control of fire blight on crabapple. In all three years, damage on Agrimycin 17-treated trees was limited to blighting of a few blossom clusters and was noticeably below the levels recorded on the unsprayed controls, as well as with the above treatments. In contrast, the trees treated with registered products, particularly Aliette WDG and Phyton 27, suffered not only considerable blighting of bloom clusters and shoot tips but also the death of some scaffold limbs. Also, fire blight severity on Aliette WDG, Phyton 27, and Kocide 101-treated trees did not differ from that on the unsprayed crabapples. On the basis of our results, Agrimycin 17 21.2W is the treatment of choice for the control of fire blight in the nursery and landscape. As indicated in previous studies on members of the apple sub-family [*Pomodidae*] (2, 3, 5, 11), the production and establishment of fire blight-resistant cultivars, rather than the intensive and costly spray program outlined in this paper, remains the preferred method of preventing destructive outbreaks of this disease in the nursery and landscape.

Literature Cited

1. Chase, A.R. 1993. Efficacy of fosetyl-Al for control of some bacterial diseases on ornamentals. Plant Dis. 77:771–776.

2. Hagan, A.K., J.R. Akridge, K.L. Bowen, J.W. Olive, and K.M. Tilt. 2001. Resistance of selected cultivars of Indian hawthorn to Entomosporium leaf spot, fire blight, and anthracnose in Alabama. J. Environ. Hort. 19:43–46.

3. Hagan, A.K., K.M. Tilt, J.D. Williams, and J.R. Akridge. 2000. Susceptibility of crabapple cultivars to several diseases in the Gulf Coast region of Alabama. J. Environ. Hort. 18:192–196.

4. Hickey, K.D., G.G. Clark, J. May, and E. McGlaughin. 1994. Evaluation of bactericides for control of fire blight blossom infections. Fungicide and Nematicide Tests 49:13.

5. Miller, J.W. 1971. Fire blight on pyracantha. Fla. Dept. of Agric. Cons. Serv. Plant Path. Cir. 109. 2 pp.

6. Moller, W.J., M.N. Schroth, and S.V. Thomson. 1981. The scenario of fire blight and streptomycin resistance. Plant Dis. 65:563–568.

7. Momol, M.T., H.S. Adwinckle, and J.L. Norelli. 1998. Evaluation of several products for control of fire blight on apple blossom, 1997. Fungicide and Nematicide Tests 53:22.

8. Paulin, J.P., C.P. Lecomte, M.N. Brisset, G. Lachaud, and P. Larue. 1990. Experiments with Aliette (fosetyl-aluminum) in fire blight control. Acta Horticulturae 273:383–389.

9. Pecknold, P.C. 1994. Evaluation of Aliette for control of fire blight of apple during bloom, 1993. Fungicide and Nematicide Tests 49:17.

10. Pecknold, P.C. and J.A. Crosby. 1993. Evaluation of Aliette for control of fire blight of apple during bloom, 1992. Fungicide and Nematicide Tests 48:17.

11. Van der Zwet, T. and S.V. Beer. 1999. Fire blight — its nature, prevention, and control: A practical guide to integrated disease management. USDA, Ag. Info. Bul. 631, 97 pp.