Research Reports:

Effect of Experimental Bactericides on Three Bacterial Diseases of Foliage Plants[1]

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Abstract

Several experimental bactericides were compared with standard bactericides for efficacy on several floral and foliage crops: *Erwinia chrysanthemi* on *Philodendron selloum, Xanthomonas campestris* pv. *hedera* on *Brassaia actinophylla* and *Hedera helix,* and *Pseudomonas cichorii* on *Chrysanthemum morifolium* and *B. actinophylla.* Compounds tested were Kocide 101 77WP (cupric hydroxide) alone and in combination with Manzate 200 80WP (mancozeb), Ciba Geigy experimental compounds 448, 115944 and 151731, and Agri-Strep 17 21.2% (streptomycin sulfate). In the majority of trials, compound 115944 provided disease control equivalent to that achieved with streptomycin sulfate. Disease control following application of 151731 was variable, while treatment with compound 448 resulted in poor control. Moderate disease control was achieved with cupric hydroxide applied alone or with mancozeb for Erwinia blight or Xanthomonas leaf spot.

Index words: English ivy, chrysanthemum, schefflera

Introduction

Bacterial diseases cause substantial losses in many floral, foliage and landscape crops. Currently available compounds have limited usefulness due to lack of efficacy (2,6), development of resistance (5,7,10,11) or phytotoxicity (9). Use of bactericides for disease control has been generally unsuccessful with the notable exception of fire blight of fruit trees (12). In addition, development of bactericides on ornamental crops is not pursued by the majority of pesticide manufacturers. Recently, Ciba Geigy Corporation made available three compounds for small scale testing on bacterial diseases of ornamentals. The research contained in this report was designed to evaluate the spectrum of activity of these compounds and to compare them to commercial bactericides currently used. The following pathogen-host systems were employed toward this end: *Erwinia chrysanthemi* on *Philodendron selloum* [4]; *Pseudomonas cichorii* on *Brassaia actinophylla* [umbrella tree, schefflera] [3] and *Chrysanthemum* X *morifolium*

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(chrysanthemum [8]); and *Xanthomonas campestris* pv. *hederae* on schefflera and *Hedera helix* L. [English ivy] [1].

Materials and Methods

All plants used in these trials were obtained from commercial producers as either seedlings or rooted cuttings. Plants were grown in a glasshouse receiving approximately 2000 ft-c maximum light with temperatures between 16 and 35 °C (60 and 95 °F). Seedlings or cuttings were planted in 10 cm (4 in) plastic pots using a potting medium consisting of Canadian peat and pine bark (1:1, by vol) which had been steam-treated 1.5 hr at 90 °C (190 °F). The medium was amended after steam-treatment with 4.2 kg (7 lbs) dolomite, 5.9 kg (10 lbs) Osmocote® 19N-2.6P-10K (19-6-12), and 0.9 kg (1.5 lb) Micromax® per cubic meter (1.3 cubic yard). Ten to 25 pots were used per treatment in a randomized complete block design.

Inocula were prepared using known bacterial pathogens from floral or foliage plants: *Erwinia chrysanthemi* (from *P. selloum*), *Pseudomonas cichorii* (from Florists' chrysanthemum) and *Xanthomonas campestris* pv. *hederae* (from schefflera). Inocula were grown on nutrient agar medium (NA, Difco) at 32 °C (90 °F). Two-day-old cultures were suspended in sterilized deionized water (SDW) and the number of colony-forming-units (cfu) determined and adjusted to about 1 x 10^8 cfu/ml with a spectrophotometer (600 nm transmission). Plants were misted starting 24 hr prior to inoculation (15 sec every 30 min from 0800 to 2000 hr), inoculated by spraying gently with a bacterial suspension to runoff using hand sprayer, after which they were placed in a polyethylene bag for 48 hr. Noninoculated controls were treated similarly except they were sprayed with sterilized deionized water. Prior to inoculation of schefflera with *P. cichorii* or *X. campestris* pv. *hederae,* and ivy with *X. campestris* pv. *hederae,* three leaves per plant were each punctured 10 times with an insect pin. Misting continued during the incubation period (2 and 14 days depending upon the test). Disease ratings consisted of number of lesions per plant for all host-pathogen combinations. *Philodendron selloum* inoculated with *E. chrysanthemi* were also rated by number of standing leaves per plant (infected leaves collapse rapidly).

Control of Erwinia blight of P. selloum.

Test 1. Ten plants per treatment were sprayed to runoff on March 14, March 21, and March 28, 1984 with the treatments and rates listed in Table 1. Plants were inoculated on March 16, 1984. Mean number of lesions per plant was recorded March 19, and mean number of standing leaves was recorded March 26, and April 3, 1984.

Test 2. A similar test was performed between April 24, and May 8, 1984 with the treatments (16 plants each) and rates listed in Table 2. Applications were made April 24, and May 1, inoculation on April 27, and ratings on April 30 (mean number of lesions/plant), and May 8, 1984 (mean number of standing leaves/plant).

Test 3. The final test employing *P. selloum* (25 plants per treatment) and *Erwinia chrysanthemi* was performed between July 25, and July 30, 1984 with the treatments and rates listed in Table 3. Plants were sprayed once on July 25, inoculated on July 27, and number of standing leaves recorded on July 30, 1984.

Control of Xanthomonas leaf spot of schefflera and English ivy.

Test 4. Schefflera and ivy (10 plants each) were sprayed on February 22 and 29, and March 7 with the treatments and rates listed in Table 4. Plants were inoculated February 24, and number of lesions/plant (with or without wounding) was recorded March 12, 1984.

Test 5. Only non-wounded schefflera (10 plants per treatment) were tested with the treatments and rates listed in Table 5. Plants were treated December 4 and 18, inoculated December 7, 1984 and number of lesions/plant recorded January 2, 1985.

Control of Pseudomonas leaf spot of chrysanthemum and schefflera.

Test 6. A single trial was performed using schefflera and chrysanthemum (10 plants each) for control of Pseudomonas leaf spot. Plants were treated on April 11 and April 18, and inoculated on April 13, 1984. Number of lesions/plant for wounded and non-wounded tissue (where appropriate) were recorded on April 25, 1984. Treatments and rates listed in Table 6 were included.

Table 1. Efficacy of various bactericides for control of Erwinia blight of *Philodendron selloum* (Test 1).

Treatment[z]	g(ai)/L	oz/100 gal	Mean no. lesions/ plant (3-19-84)	Mean no. leaves standing/plant 3-26-84	4-3-84
Noninoculated control	——	——	0 a[y]	15.9 c	16.6 d
Inoculated control	——	——	21.9 c	7.1 a	6.9 a
CGA-115944	1.1	29.4	5.2 ab	10.6 b	11.0 bc
CGA-115944	1.3	34.8	3.1 a	12.0 b	13.1 c
CGA-448	0.3	8.0	14.0 bc	7.3 a	9.0 ab
CGA-448	0.5	13.4	5.6 ab	9.5 ab	8.9 ab
Streptomycin sulfate	0.3	16.0	0.7 a	16.4 c	16.7 d

[z]Applications were made on March 14, 21 and 28, 1984 with inoculation on March 16, 1984.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

Results and Discussion

Control of Erwinia blight of P. selloum.

Test 1. Mean number of lesions per plant for *P. selloum* inoculated with *E. chrysanthemi* was greatest for inoculated control plants and least for noninoculated control plants. Streptomycin sulfate, CGA-115944, and the high rate of CGA-448 gave control equivalent to the noninoculated control treatment (Table 1). Streptomycin sulfate was the only compound that provided acceptable control based on the mean number of standing leaves at the conclusion of the test.

Test 2. All bactericide treatments reduced the mean number of lesions/plant compared to the inoculated control (Table 2). However, optimum control on May 8 was achieved only with the streptomycin sulfate treat-

Table 2. Efficacy of various bactericides for control of Erwinia blight of *Philodendron selloum* (Test 2).

Treatment[z]	g(ai)/L	oz/100 gal	Mean no. lesions/ plant (4-30-84)	Mean no. leaves standing/ plant (5-8-84)
Noninoculated control	—	—	0 a[y]	36.6 f
Inoculated control	—	—	32.8 e	8.2 a
CGA-115944	1.1	29.4	12.5 bc	10.2 abc
CGA-151731	0.5	13.4	18.1 d	9.5 ab
CGA-151731	1.1	29.4	12.8 bc	13.3 bc
CGA-448	0.5	13.4	19.2 d	10.2 abc
CGA-448	1.1	29.4	11.8 bc	12.9 bc
CGA-115944 and	0.5	13.4	12.9 bc	12.2 bc
CGA-448	0.5	13.4		
Streptomycin sulfate	0.1	8.0	10.8 b	19.5 d
Streptomycin sulfate	0.3	16.0	8.6 b	23.6 e
Cupric hydroxide	0.9	16.0	15.9 cd	12.0 abc
Cupric hydroxide	0.9	16.0	12.8 bc	13.8 c
and mancozeb	1.3	24.0		

[z]Applications were made April 24, 1984 and May 1, 1984 with inoculation on April 27, 1984.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

Table 3. Efficacy of various bactericides for control of Erwinia blight of *Philodendron selloum* (Test 3).

Treatment[z]	g(ai)/L	oz/100 gal	Mean no. leaves standing/ plant (7-30-84)
Noninoculated control	—	—	6.4 c[y]
Inoculated control	—	—	1.1 a
CGA-115944	0.5	13.4	2.3 b
CGA-151731	0.5	13.4	2.3 b
Cupric hydroxide	0.9	16.0	2.0 b
Cupric hydroxide	0.9	16.0	1.6 ab
and mancozeb	1.3	24.0	

[z]Applications were made a single time on July 25, 1984 with inoculation on July 27, 1984 and rating on July 30, 1984.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

Table 4. Efficacy of several bactericides for control of *Xanthomonas campestris* pv. *hederae* on *Brassaia actinophylla* and *Hedera helix* (Test 4).

			Mean no. lesions/plant		
			Schefflera		Ivy
Treatment[z]	g(ai)/L	oz/100 gal	wounded	nonwounded	wounded
Noninoculated control	—	—	0 a[y]	0 a	0 a
Inoculated control	—	—	3.8 c	47.9 b	2.0 d
CGA-115944	1.1	29.4	0.9 ab	7.0 a	1.1 bcd
CGA-115944	1.3	34.8	1.8 b	25.0 b	1.7 cd
CGA-448	0.3	8.0	0 a	4.8 a	0.9 abc
CGA-448	0.5	13.4	0.5 a	8.8 a	0.2 ab
Streptomycin sulfate	0.3	16.0	0.2 a	5.0 a	0.1 ab

[z]Applications were made February 22 and 29, 1984 and March 7, 1984, with inoculation on February 24, 1984 and ratings on March 12, 1984.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

Table 5. Efficacy of several bactericides for control of *Xanthomonas campestris* pv. *hederae* on *Brassaia actinophylla* (Test 5).

Treatment[z]	g(ai)/L	oz/100 gal	Mean no. lesions/plant
Noninoculated control	—	—	0 a[y]
Inoculated control	—	—	19.8 b
CGA-115944	0.5	13.4	7.9 ab
CGA-151731	0.5	13.4	7.4 ab
CGA-448	0.5	13.4	14.2 b
Cupric hydroxide	0.9	16.0	7.5 ab
and mancozeb	1.3	24.0	

[z]Applications were made December 4 and 18, 1984 with inoculation on December 7, 1984 and rating January 2, 1985.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

Table 6. Efficacy of various bactericides for control of *Pseudomonas cichorii* on *Chrysanthemum morifolium* and *Brassaia actinophylla* (Test 6).

			Number of lesions/plant			
			Chrysanthemum	Schefflera		
Treatment[z]	g(ai)/L	oz/100 gal	nonwounded	nonwounded	wounded	both
Noninoculated control	—	—	0 a[y]	0 a	0 a	0 a
Inoculated control	—	—	19.5 c	10.3 d	45.0 d	55.3 d
CGA-115944	1.1	29.4	4.7 ab	2.8 abc	22.2 bc	25.0 bc
CGA-115944	1.3	34.8	10.0 b	5.1 c	24.8 bc	29.9 bc
CGA-448	0.5	13.4	18.4 c	4.1 bc	14.9 b	19.0 b
CGA-448	0.8	21.4	22.6 c	4.0 bc	30.9 c	31.4 bc
CGA-151731	0.5	13.4	8.5 b	5.6 c	30.5 c	35.2 c
CGA-151731	1.1	29.4	9.9 b	1.6 ab	24.7 bc	25.3 bc
Streptomycin sulfate	0.3	16.0	10.2 b	3.9 bc	18.5 bc	22.4 bc

[z]All ratings were made on April 25, 1984 following inoculation on April 13, 1984 with treatments applied on April 11 and 18, 1984.

[y]Means within columns were separated using Duncan's new multiple range test (P = 0.05). Figures in the same column followed by the same letter are not significantly different.

ment. Each of the numbered compounds at the high rate, the combination of CGA-115944 and CGA-448 (0.5 g (ai)/L each) or the combination of cupric hydroxide and mancozeb (0.9 and 1.3 g (ai)/L) provided the next best sets of controls. The treatment resulting in the most standing leaves/plant was the high rate of streptomycin sulfate with none of the other treatments providing an acceptable degree of control.

Test 3. In this test, the mean number of standing leaves was highest for plants treated with either CGA-151731 or CGA-115944 compared to the noninoculated control (Table 3). None of the treatments provided an acceptable degree of control in this test.

Control of Xanthomonas leaf spot of schefflera and English ivy.

Test 4. All bactericide treated scheffleras had significantly fewer lesions/plant compared to inoculated control plants with both CGA-448 treatments providing control equivalent to the noninoculated control on both wounded and non-wounded tissue (Table 4). The high rate of CGA-115944 did not provide acceptable control of Xanthomonas leaf spot. Similar results were found for English ivy (Table 4).

Test 5. In the second test with Xanthomonas leaf spot of schefflera no clear differences were established between any of the treatments. However, the mean number of lesions/plant was comparable to the noninoculated control when plants were sprayed with CGA-115944, CGA-151731, or the cupric hydroxide-mancozeb combination (Table 5). In this test, CGA-448 failed to provide a significant degree of Xanthomonas control.

Test 6. Control of Pseudomonas leaf spot of both chrysanthemum and schefflera was evaluated in this test. On chrysanthemum, the mean number of lesions/plant was lowest for plants treated with CGA-115944 (1.1 g (ai)/L) compared to the noninoculated control (Table 6). Significant control of Pseudomonas leaf spot was also achieved with both rates of CGA-115944, both rates of CGA-151731 and streptomycin sulfate. Neither rate of CGA-448 provided a significant level of control on chrysanthemum. On schefflera, none of the compounds provided control equivalent to the noninoculated control. On this host, a significant level of control was achieved with each of the bactericides with little difference noted between treatments.

Significance to the Nursery Industry

In these trials, good control of all three bacterial diseases was achieved when plants were treated with streptomycin sulfate. Use of streptomycin sulfate is limited, however, due to bacterial resistance and phytotoxicity. Cupric hydroxide and mancozeb combinations provided moderate control of Erwinia blight and Xanthomonas leaf spot. The most promising new compound appears to be CGA-115944. In the majority of trials, this compound provided control equivalent to that provided by

streptomycin sulfate. In addition, the compound was relatively safe on *P. selloum,* schefflera, chrysanthemum, and English ivy. None of the numbered compounds from Ciba Geigy are classified as antibiotics.

(*Ed note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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Effects of Pruning on Root and Shoot Growth of *Ilex crenata* 'Compacta'[1]

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Abstract

In 2 experiments, shoot pruning at potting reduced root growth of transplanted rooted cuttings (liners). However, tip pruning of plants increased root growth compared to severe pruning (50% of shoots) and increased shoot numbers compared to nonpruned plants. In experiment 1 severe shoot pruning of transplanted liners in September resulted in increased shoot numbers compared to nonpruned plants, while in a second experiment, severe shoot pruning in May had no effect on shoot numbers.

Index words: Japanese holly, pruning, growth and development

Introduction

In commercial nurseries, liners are produced during the spring and summer, and stepped up to larger containers the following year. Liners in small pots become leggy and at potting are pruned severely to develop a compact plant. Pruning increases branching of most woody landscape crops (1,2,3).

Previous research evaluating pruning of woody plants has shown that shoot pruning suppressed root growth (4,7,8). Fordham (4), working with *Camellia sinensis* L. tea, showed that periods of maximum shoot growth are associated with minimal root growth. Mertens and Wright (5) reported that 'Helleri' and 'Rotundifolia' holly growth are episodic in nature, with active root growth preceding a shoot flush by 1 to 2 weeks. Understanding the effects of pruning liners at potting on other growth responses may be useful in modifying cultural practices to maximize growth of recently transplanted liners in container production of woody landscape crops. To enhance knowledge in this area 2 experiments

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