Influence of an Insecticidal Soap on Several Foliar Diseases of Foliage Plants

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ABSTRACT

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An insecticidal soap was tested against the following pathogen-suscept combinations: *Alternaria panax* + *Brassaia actinophylla* (schefflera), *Bipolaris setariae* + *Chrysalidocarpus lutescens* (areca palm), *Fusarium moniliforme* + *Dracaena marginata* (red-edge dracaena), and *Myrothecium roridum* + *Dieffenbachia maculata* (dieffenbachia). In greenhouse trials, soap applied at the rate recommended for mite control (12.62 mg a.i./L) significantly reduced the severity of Alternaria leaf spot of *B. actinophylla* and Bipolaris leaf spot of *C. lutescens*. In contrast, the same rate of soap applied to *D. maculata* and *D. marginata* significantly increased fungal leaf spots of these plants. In laboratory trials with all four pathogens, soap incorporated into culture medium at rates as low as 0.63 mg a.i./L significantly reduced colony growth.

Additional key word: phytotoxicity

In general, pesticides have been the key to controlling insect, mite, and pathogen pests of foliage plants in greenhouses. The need for pest control in the interior environment has increased in the past few years with greater use of plants in malls, public buildings, and private homes. Because of the nature of this environment, use of most pesticides available for greenhouse and field has not been possible. Pesticides such as soaps have been used for insect and mite control (2,3,5) with a high degree of success (4,7). The effects of these soaps on plant pathogens have received little attention because foliar diseases are not a serious problem in the interior environment. These soaps, however, might be useful for insect or mite control in the greenhouse, where diseases can be serious.

Few insecticides or miticides have known effects on diseases of greenhouse plants. Recently, acephate insecticide (Orthene) was shown to decrease Alternaria leaf spot of schefflera in an apparent interaction with the host plant (L. S. Osborne and A. R. Chase, *unpublished*). These effects become especially important when developing an integrated approach to pest control. The purpose of this research was to determine the influence of an insecticidal soap on several foliar diseases of foliage plants and on the growth of the pathogens in vitro.

MATERIALS AND METHODS

The insecticidal soap (50.5% potassium salts of fatty acids and 49.5% inert ingredients) used in this study was obtained from Safer Agro-Chem, Inc., Jamul, CA 92035. The influence of this soap on disease severity was tested on the

Table 1. Influence of insecticidal soap, applied 24 hr before inoculation of *Alternaria panax* on *Brassaia actinophylla* (schefflera), on disease severity

Concentration of soap (mg a.i./L)	Mean no. of lesions per 10 plants		
	Test 1	Test 2	Test 3
0 (water)	10.6	10.2	9.8
6.31	1.7	0.1	8.9
12.62[a]	0.7	0.3	2.9
25.24	0.3	0.1	1.6
Regression analyses[b]	**%TrSS**	**%TrSS**	**%TrSS**
Linear	57.46 **	47.00 **	84.12 **
Quadratic	36.34 **	41.05 **	3.98 ns
Cubic	6.20 ns	11.94 ns	11.90 ns

[a] Recommended rate of soap for mite control.

[b] Regression analyses were performed on tests with significant differences between treatments as determined by an F test. The analyses are given as the percentage of the treatment sum of squares (TrSS) for which each term accounts, followed by the significance level of the corresponding F values denoted as follows: ** = 0.01 and ns = not significant.

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following pathogen-suscept combinations: *Alternaria panax* Whetzel + *Brassaia actinophylla* Endl. (schefflera), *Bipolaris setariae* (Saw.) Shoemaker + *Chrysalidocarpus lutescens* Wendl. (areca palm), *Fusarium moniliforme* Sheld. + *Dracaena marginata* Lam. (dracaena), and *Myrothecium roridum* Tode ex. Fr. + *Dieffenbachia maculata* Lodd. G. Don 'Perfection' (dieffenbachia). All plants were obtained from growers or produced from seeds and grown in a steam-sterilized potting medium consisting of Canadian peat, cypress shavings, and pine bark (2:1:1, v/v/v). The medium was amended with 4.4 kg Osmocote (19-6-12 slow-release fertilizer; Sierra Chemical Co., Milpitas, CA), 4.2 kg dolomite, and 0.9 kg Micromax (micronutrient source, Sierra Chemical Co.) per cubic milliliter. Plants were grown in 10-, 12.5-, or 15-cm plastic pots, according to their size, on a greenhouse bench, with about 12 klux natural light and temperatures ranging from 16 to 30 C. Plants were watered by hand before inoculation to maintain dry foliage and were not watered during incubation. After the incubation period, they were watered from overhead to promote disease. All plants were free of lesions and most visible pesticide residues at the time of inoculation.

Table 2. Influence of insecticidal soap, applied 24 hr before inoculation of *Bipolaris setariae* on *Chrysalidocarpus lutescens* (areca palm), on disease severity

Concentration of soap (mg a.i./L)	Mean no. of lesions per 10 plants		
	Test 1	Test 2	Test 3
0 (water)	15.2	77.0	45.2
6.31	8.9	22.0	18.8
12.62[a]	6.0	22.5	7.0
25.24	0.6	13.0	1.5
Regression analyses[b]	**%TrSS**	**%TrSS**	**%TrSS**
Linear	95.10**	60.33**	78.11**
Quadratic	4.06 ns	28.57 **	21.34 **
Cubic	0.84 ns	11.10 **	0.55 ns

[a] Recommended rate of soap for mite control.
[b] Regression analyses were performed on tests with significant differences between treatments as determined by an F test. The analyses are given as the percentage of the treatment sum of squares (TrSS) for which each term accounts, followed by the significance level of the corresponding F value denoted as follows: ** = 0.01 and ns = not significant.

Table 3. Influence of insecticidal soap, applied 24 hr before inoculation of *Fusarium moniliforme* on *Dracaena marginata* (red-edge dracaena), on disease severity

Concentration of soap (mg a.i./L)	Mean disease severity rating for 10 plants[a]		
	Test 1	Test 2	Test 3
0 (water)	1.4	2.0	2.0
6.31	1.7	1.8	2.4
12.62[b]	2.6	2.1	2.4
25.24	2.0	2.6	2.6
Regression analyses[c]	**%TrSS**	**%TrSS**	**%TrSS**
Linear	31.54 *	81.63 **	ns
Quadratic	49.31 **	11.87 ns	ns
Cubic	19.15 ns	6.50 ns	ns

[a] Number assigned on the following scale: 1 = no disease, 2 = 1–10 lesions, 3 = 11–26 lesions, 4 = severely coalescing lesions, and 5 = bud death.
[b] Recommended rate of soap for mite control.
[c] Regression analyses were performed on tests with significant differences between treatments as determined by an F test. The analyses are given as the percentage of the treatment sum of squares (TrSS) for which each term accounts, followed by the significance level of the corresponding F value denoted as follows: ** = 0.01, * = 0.05, and ns = not significant.

Table 4. Influence of insecticidal soap, applied 24 hr before inoculation of *Myrothecium roridum* on *Dieffenbachia maculata* (dieffenbachia), on disease severity

Concentration of soap (mg a.i./L)	Mean no. lesions per five plants[a]		
	Test 1	Test 2	Test 3
0 (water)	2.8	0.1	2.6
6.31	7.6	0.5	7.8
12.62[b]	6.4	0.7	7.6
25.24	8.2	0.2	6.8
Regression analyses[c]	**%TrSS**	**%TrSS**	**%TrSS**
Linear	58.15 **	ns	29.62 **
Quadratic	16.32 *	ns	57.66 **
Cubic	25.53 *	ns	12.72 **

[a] Twelve lesions were possible for each plant.
[b] Recommended rate of soap for mite control.
[c] Regresssion anlyses were performed on tests with significant differences between treatments as determined by an F test. The analyses are given as the percentage of the treatment sum of squares (TrSS) for which each term accounts, followed by the significance level of the corresponding F value denoted as follows: ** = 0.01, * = 0.05, and ns = not significant.

Isolates of the pathogens were obtained from naturally infected plants. Cultures were maintained on slants of potato-dextrose agar medium (PDA; infusion from 250 g boiled potatoes, 20 g dextrose, and 20 g agar per liter) at 15 C. Inocula were grown on PDA plates (*F. moniliforme* and *M. roridum*) or V-8 juice agar medium plates (18% V-8 juice cleared with 4.5 g $CaCO_3$ and 15 g agar per liter) (*A. panax* and *B. setariae*) under fluorescent light (2 klux, 8 hr/day) at 24–26 C for 7–14 days before use. Conidia were collected from the cultures by adding sterile deionized water (SDW) to them and gently rubbing the surfaces with a sterilized rubber spatula. Conidial suspensions were adjusted as follows: *A. panax*, 1×10^4; *B. setariae*, 1×10^3; and *F. moniliforme* and *M. roridum*, 1×10^6 conidia per milliliter. All plants were inoculated by spraying to runoff and incubated for 72 hr in a polyethylene bag. Dieffenbachias were wounded before inoculation by puncturing each of four leaves per plant three times with a sterile dissecting needle. Control plants were treated similarly but sprayed with SDW only. Each treatment consisted of 10 plants (except dieffenbachia tests, which had five plants). Treatments were 1) sprayed with water, inoculated with water; 2) sprayed with water, inoculated with conidia; 3) sprayed with soap (6.31 mg a.i./L), inoculated with conidia; 4) sprayed with soap (12.62 mg a.i./L), inoculated with conidia; and 5) sprayed with soap (25.24 mg a.i./L), inoculated with conidia. Plants were rated for disease severity 5–14 days after the bags were removed by counting the number of lesions per plant or assigning a severity rating based upon the number and size of lesions per plant. This test was performed three times with each pathogen-suscept combination.

The influence of this insecticidal soap on growth of the pathogens was tested by incorporating soap into molten PDA (BBL, Cockeysville, MD). Each plate (100 × 15 mm) contained 15 ml of medium. A single 8-mm disk from the advancing edge of a fungal colony grown on PDA was placed in the center of each of seven plates for the following treatments: 1) PDA without soap, 2) 12.62 mg a.i. of soap per liter of PDA, 3) 25.24 mg a.i. of soap per liter of PDA,

and 4) 50.48 mg a.i. of soap per liter of PDA. Plates were incubated under the conditions described earlier for 5–7 days and colony diameters were recorded. This test was performed with each of the pathogens, using each rate once. Similar tests were performed using lower rates (12.62, 6.31, 0.63, and 0.06 mg a.i. soap per liter of PDA). Four tests were performed using these lower rates.

RESULTS AND DISCUSSION

Disease severity was reduced for Alternaria leaf spot of schefflera and Bipolaris leaf spot of areca palm when soap was sprayed onto plants 24 hr before inoculation (Tables 1 and 2). In most tests, even at half the recommended rate, the severity of leaf spot was reduced compared with water-treated controls. Lesion size on plants sprayed with soap was reduced as much as 50% compared with the untreated controls. In contrast, Fusarium leaf spot of dracaena and Myrothecium leaf spot of dieffenbachia were significantly more severe when compared with water-treated controls (Tables 3 and 4). In most trials, the response of the pathogen-suscept combination to soap had both linear and quadratic components (Tables 1–4), with both significant at the 0.01 level. Generally, higher rates of soap resulted in a stronger reaction: higher rates of soap resulted in either less disease (Tables 1 and 2) or more disease (Tables 3 and 4). The greatest effect was noted between water-sprayed control plants and the lowest rate of soap-sprayed plants. Plants sprayed with higher rates of soap showed smaller differences as the rate increased. Uninoculated control plants remained free of disease during these trials.

Growth of all four pathogens on soap-amended PDA was significantly less than on unamended PDA (Table 5). This reduction in growth appeared to be linear with increased soap concentration. Rates as low as 0.63 mg a.i./L resulted in reduced growth (colony diameter) of all four pathogens. Higher rates of soap (25.24 and 50.48 mg a.i./L of PDA) resulted in complete inhibition of growth for each of the four pathogens. *Alternaria panax* had the greatest reduction in growth, followed by *B. setariae*, and *M. roridum*. *F. moniliforme* had the greatest tolerance to soap.

The insecticidal soap was fungitoxic to all four pathogens in the in vitro trials, but this action did not account for all responses of the pathogen-suscept combinations. Because soap increased severity of Fusarium leaf spot and Myrothecium leaf spot, the effect may be on the host plant. Soap, however, caused no visible symptoms of phytotoxicity on these two genera. Of the four plants tested, schefflera is the most sensitive to pesticides (10) and is the only plant that showed signs of phytotoxicity during these trials, as noted in the past (4). Despite damage from soap applications, Alternaria leaf spot was consistently reduced in these treatments. Phytotoxicity from pesticides has been involved in other diseases, such as increased severity of seedling blight of cotton that had been treated with herbicides (6). Richardson (9) noted differences in severity of early blight and Fusarium wilt of tomato on plants treated with certain insecticides and herbicides. In his study, specific pesticides did not always influence the two diseases in the same manner. In another study, only two of 19 pesticides tested increased severity of Helminthosporium blight of barley, indicating that increasing severity of disease may not be common (8). The action of this soap may be to damage or interfere with the plant cuticle, such as the damage noted on plants treated with the herbicide S-ethyl dipropyldithiocarbamate (1).

Although this insecticidal soap is primarily an insecticide, it has a distinct effect on fungal plant pathogens and can decrease or increase disease severity, depending upon the pathogen-suscept combination involved. The most important aspect of such nontarget effects is that the increased knowledge should allow development of an integrated approach to pest control by minimizing host stress through choice of the best pesticides for plant production.

Table 5. Effects of low rates of insecticidal soap on in vitro growth of four foliage plant pathogens

Concentration of soap (mg a.i./L)	Mean pathogen colony diameter (mm)			
	Alternaria panax	*Bipolaris setariae*	*Fusarium moniliforme*	*Myrothecium roridum*
0	37.0	84.0	70.0	37.7
0.06	42.4	84.0	68.9	35.6
0.63	35.0	68.4	61.4	33.7
6.31	19.0	25.7	32.3	19.7
12.62[a]	8.0[b]	8.0	16.6	9.6
Regression analyses[c]	**%TrSS**	**%TrSS**	**%TrSS**	**%TrSS**
Linear	95.50 **	92.97 **	95.97 **	98.09 **
Residual	4.50 ns	7.03 ns	4.03 ns	1.91 ns

[a] Equivalent to recommended rate of soap for mite control.
[b] Original inoculum disk was 8 mm, thus no growth was seen here.
[c] Regression analyses were performed for tests in which a significant difference between treatments was indicated by the *F* test. Linear regressions were performed and represented by the percentage of the total treatment sum of squares (TrSS) for which they accounted. The significance level of the corresponding *F* value is denoted as follows: ** = 0.01 and ns = not significant.

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