Controlling Powdery Mildew in Euonymus with Polymer Coatings and Bicarbonate Solutions

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Abstract. Powdery mildew in euonymus (*Euonymus japonica* Thunb.) plants, caused by *Oidium euonymi-japonica* (Arcang.) Sacc., was controlled by applying various polymer coatings or an aqueous solution of sodium or potassium bicarbonate plus horticultural Sun Spray (SS) Ultra Fine Oil 1% (v/v) to plant foliage. The combined treatment (bicarbonate + oil) was more effective than either of the two materials alone. The results indicate that sodium or potassium (but not ammonium) bicarbonate solutions mixed with SS seems to be a useful biocompatible fungicide for controlling powdery mildew in euonymus plants. Some of the polymer coatings effectively reduced disease levels when applied immediately after the symptoms first appeared.

Powdery mildew disease caused by *Oidium euonymi-japonica* is severely destructive to euonymus plants from early spring until early autumn (Koul, 1980; Tokushige, 1953). Nademejad (1966) reported serious damage to *E. japonica* plants caused by the pathogen and stressed the need for chemical treatment to control powdery mildew. Chemical fungicides often fail to control foliar diseases, mainly because the pathogen develops resistance (Dekker, 1976). Various epidermal polymer coatings were effective in controlling powdery mildew on some other crops (Elad et al., 1990; Hagiladi and Ziv, 1986; Kamp, 1985; Ziv and Hagiladi, 1984). In China, the antitranspirant Masbrene (dodecyl alcohol; Aefachemi, Sheng Wan, Hong Kong) effectively controlled 12 foliar diseases on nine diverse hosts (Han Jing-Sheng, 1990).

When applied to leaves as a pre-inoculation treatment to prevent a pathogen from becoming established in plant tissue, protective coatings such as antitranspirants, oils, waxes, silicones, and various surfactant adhesives seem to be promising alternatives to chemical fungicides. In addition, these coatings do not pollute the environment as do chemical fungicides.

Powdery mildew on cucumber (*Cucumis sativus* L.) and roses (*Rosa* spp.) was controlled effectively by sodium and potassium bicarbonate solutions when mixed with surfactants (Homma et al., 1981) or horticultural oil (Horst et al., 1992) and applied to the leaves. The inhibitory effects of applying sodium or potassium bicarbonate solutions, alone or combined with Sun Spray (SS) Ultra-Fine Spray Oil (are fined petroleum distillate; Safer,

Newton, Mass.), to powdery mildew (*Sphaerotheca fuliginea* Schlechtend; Fr. Pollacci) on cucurbit foliage were demonstrated in greenhouse and field trials (Ziv and Zitter, 1992).

The purpose of this work was to evaluate the use of various coatings and bicarbonate solutions in controlling powdery mildews in *E. japonica*.

Four-year-old, 60-cm-tall *E. japonica* plants were grown in four rows, 35 cm apart, under garden conditions. Experiments were conducted in Mar. 1990 and 1992. The following polymer coatings were used in 1990: Nu Film 17 (di-lpmenthene; Miller Chemical and Fertilizer Co., Hanover, Pa.); Bio-Film (a surfactant containing alkylaryl-polyethoxy-ethanol, free and combined fatty acids, glycol ethers, di-alkyl benzenedicarboxylate and isopropanol; Callo Agricultural Chemical, Overland Park, Kan.); and Spray & Grow (a wax emulsion formulation; Barki and Anak, Ramat Aviv, Israel). In 1992, Nu Film 17, SS, Masbrane, Acrylic "Anti-Stress" polymer (AG, Fresno Calif.), and bicarbonate solutions (KHCO₃, NaHCO₃, and NH₄HCO₃), with or without SS, were used. The emulsion of the polymer coatings in distilled water was 2% and 1% in 1990 and 1992, respectively. The emulsion of the bicarbonate solutions was 1% and 2% (w/v).

One day after the symptoms of a natural powdery mildew infection appeared on a few leaves, the products were hand sprayed to runoff. The plants were sprayed three times at 10-day intervals. In the second trial, plants were also treated with bicarbonate solutions; with or without 1% (v/v) SS, they were sprayed weekly, starting 27 Mar., for a total of five applications.

Five branches of the same age and size on each of four plants were selected for each

Table 1. Effect of polymer coatings on powdery mildew severity in *Euonymus japonica* (1990 trial).

Treatment	Leaf area covered by pathogen (%)			
	No. days after first treatment ²			
	14	26	40	55
Water (control)	8.3 ^a	19.3 a	28.6 a	41.2 a
Spray & Grow	5.4 a	7.1 b	11.9 b	19.8 b
Nu Film 17	5.7 a	6.0 b	9.4 b	13.1 b
Bio-Film	3.9 a	4.4 b	4.8 c	5.9 c

¹First treatment on 16 Mar. 1990 (1 day after symptoms appeared).

²Mean of five branches × four plants (replications).

³Mean separation in columns by Duncan's multiple range test, *P* = 0.05.

Table 2. Effect of bicarbonate solutions [with or without Sun Spray (SS) oil] and polymer coatings on powdery mildew severity in *Euonymus japonica* (1992 trial).

Compound and concn	Leaf area covered by pathogen (%)			
	No. days after first treatment ²			
	19	25	32	40
Water (control)	93.4 ^a	96.1 a	98.2 a	100.0 a
KHCO ₃ , 1%	21.8 de	25.2 d	26.0 cd	28.3 cd
+ SS, both 1%	11.8 e	12.9 de	18.1 de	20.0 d
2% + SS, 1%	8.9 e	11.2 e	13.8 e	15.6 de
NaHCO ₃ , 1%	15.2 e	18.6 d	22.1 d	26.9 d
+ SS, both 1%	21.8 de	20.9 d	23.2 d	21.7 d
2% + SS, 1%	9.1 e	10.5 e	12.9 e	14.1 de
NH ₄ HCO ₃ , 1%	58.2 b	66.8 b	72.0 ab	81.1 ab
+ SS, both 1%	34.6 c	39.5 bc	40.1 b	41.2 bc
Bio-Film, 1%	25.7 d	22.9 d	29.1 d	31.0 d
NuFilm 17, 1%	28.1 d	22.9 d	32.4 cd	36.1 cd
Anti-Stress, 1%	42.2 bc	49.8 b	39.8 bc	45.8 bc
Masbrane, 1%	19.8 d	25.7 cd	26.1 de	28.0 d
Bayleton	64.2 b	59.4 b	67.0 b	68.6 b
SS, 1%	31.8 cd	33.5 cd	36.0 cd	39.1 c

¹First treatment on 27 Mar. 1992.

²Five branches × four plants served as replications for each treatment. Disease level is the percent leaf area (mean of 20 leaves for each treatment) covered by the pathogen out of total leaf area.

³Numbers followed by the same letter do not differ significantly in the column according to Duncan's multiple range test, *P* = 0.05.

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treatment (total of 20 branches per treatment). Plastic sleeves (20 cm in diameter and 60 cm long) were used during spraying to prevent contamination due to wind drift. Nontreated control branches were sprayed with water alone. In the second trial, four control plants were sprayed with the fungicide Bayleton (triadimefon) at 1 g a.i./liter.

Disease severity was evaluated weekly by visually estimating the percentage of leaf area covered by powdery mildew.

In the 1990 experiment, the three polymer coatings effectively prevented powdery mildew on *E. japonicu* compared with control branches (Table 1). After 55 days, Bio-Film was superior to the other products examined. In the second experiment, only the two most effective polymer coatings were examined—Bio-Film and Nu Film 17. The concentration of these two polymer coatings was 1% to learn the effect on powdery mildew at a reduced dose. During the growing season, young leaves were more vulnerable than older ones to pathogen attack and needed renewed protection every 10 days. A similar phenomenon was observed in roses (Hagiladi and Ziv, 1986).

In 1992, the most effective products in controlling powdery mildew in euonymus plants were Na and K bicarbonate (HCO_3^-) solutions (Table 2). The NH_4^+ might be toxic in the concentration applied to the euonymus plants. This toxicity could enable powdery mildew to develop. Potassium and sodium bicarbonate solutions, in the presence of SS, and sodium bicarbonate alone, were significantly more effective than any of the polymer coatings.

Bio-Film, Nu Film 17, and Masbrane did not significantly differ in their ability to protect euonymus plants from powdery mildew. Anti-Stress was the least effective. The protection pattern obtained by the products examined was maintained over time (Table 2).

In cucurbits, using bicarbonate solutions combined with SS effectively controls powdery mildew (Ziv and Zitter, 1992). Sodium and potassium bicarbonate solutions at 1% or 2%, when mixed with SS, reduced disease severity on euonymus plants to 12% to 21% of that on nontreated control plants (Table 2, Fig. 1). Ammonium bicarbonate had no such effect. The inhibitory effect of bicarbonate solutions mixed with oil lasted 10 to 14 days after treatment. Bayleton (Table 2) was ineffective in controlling powdery mildew on euonymus plants. The fungicides 1-[2-(2,4-dichlorophenyl)-4 propyl- 1,3 dioxolan-2-ynethyl] 1 *H*-1,2,4 triazol [Tilt (propiconazole)] and methyl 1-(butylcarbamoyl)benzimidazol-2-ylcarbamate [Banlate (triamefon)] also were ineffective in controlling powdery mildew on euonymus plants (unpublished data).

The results of this preliminary study indicate that it may be possible to replace conventional chemical fungicides with polymer coatings or bicarbonate salts, alone or in combination, as part of the integrated pest management strategy for controlling powdery mildew on euonymus plants.

A limitation encountered with these treatments was their failure to control powdery

Fig. 1. Effect of KHCO_3 + 1% (v/v) Sun Spray oil on powdery mildew of *Euonymus japonica* plant (left) compared with nontreated control plant (right).

Fig. 2. Adaxial surface of nontreated leaves of euonymus plants (top), and of leaves treated with KHCO_3 at 1% (center), and the abaxial side of leaves treated with KHCO_3 (bottom).

mildew on the abaxial surface of the leaf, presumably because the coatings inadequately covered that surface (Fig. 2). Application technology improvements will maximize the amount of coating deposited on both leaf surfaces. Also, since control by these materials is protective in nature (Ziv and Zitter, 1992), they must be applied soon after the disease appears to be effective.

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