

Entomosporium Leaf Spot Control on Red-tip Photinia in the Landscape¹

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Abstract

In 2006, 2007, and 2008, efficacy of the soil-applied fungicide drench All-In-One Rose & Flower Care [All-In-One] (tebuconazole) was compared with the foliar-applied fungicides Daconil Weather Stik (chlorothalonil), Immunox Multipurpose Fungicide (myclobutanil), RosePride Disease Control Concentrate (triforine), and Disease Control for Roses, Flowers & Shrub Concentrate (tebuconazole) for the control of *Entomosporium* leaf spot on field-grown red-tip photinia (*Photinia* × *fraseri* 'Birmingham'). While the label rate of All-In-One drench was poured over the soil surface around the base of each plant at monthly intervals, the foliar applied fungicides were applied at label rates at 2-week intervals to runoff. Over the study period, drenches of All-In-One failed to protect photinia from *Entomosporium* leaf spot, while the foliar-applied fungicides significantly reduced disease levels. Defoliation on the non-fungicide treated controls was similar to the All-In-One drench and ranged over the study period from 25 to nearly 75%. In contrast, little if any leaf spotting and no defoliation occurred in any of the study years on the photinia treated with Daconil Weather Stik, Immunox Multi-purpose Fungicide, RosePride Disease Control Concentrate, and Disease Control for Roses, Flowers & Shrub Concentrate. Poor efficacy of the All-In-One was attributed to an inadequate concentration of the fungicide component tebuconazole when applied at the label drench rate.

Index words: chemical control, tebuconazole, chlorothalonil, myclobutanil, triforine, *Entomosporium mespili*, photinia, Immunox Multipurpose Fungicide, RosePride Disease Control, Disease Control for Roses, Flowers & Shrub Concentrate, All-In-One Rose & Flower Care.

Species used in this study: *Photinia* × *fraseri* 'Birmingham'.

Chemicals used in this study: Daconil Weather Stik 6F (chlorothalonil, tetrachloroisophthalonitrile); Immunox Multipurpose Fungicide (myclobutanil, a-butyl-a-(chlorophenyl)-1*H*-1,2,4 triazole-1-*pr*panenitrile); All-In-One Rose & Flower Care and Disease Control for Roses, Flowers & Shrub Concentrate (tebuconazole, α-[2-(4-chlorophenol) ethyl]-α-(1,1-dimethylethyl) 1*H*-1,2,4 triazole-1-ethanol); RosePride Disease Control Concentrate (triforine, 1,4-bis(2,2,2-trichloro-1-formamidoethyl)piperazine; 1,1'-piperazine-1,4-diyl-di-[N-(2,2,2-trichloroethyl)formamide]; N,N'-[1,4-piperazinediylbis(2,2,2-trichloro-ethylidene)]bisformamide).

Significance to the Nursery Industry

Disease control in landscape plantings with herbaceous or woody ornamentals vulnerable to aggressive plant pathogenic fungi such as *Entomosporium mespili* presents a serious challenge for homeowners or renters. Foliar-applied fungicides often require multiple applications with a hand sprayer at 1 to 2 week intervals, to maintain the protective barrier needed to prevent infection and subsequent development of diseases like *Entomosporium* leaf spot on red tip photinia (*Photinia* × *fraseri* 'Birmingham'). All-In-One Rose & Flower Care is formulated with a systemic fungicide (tebuconazole) along with a systemic insecticide (imidacloprid) and a fertilizer as a drench treatment for broad-spectrum disease and insect control on herbaceous and woody ornamentals in residential landscapes. While expensive (\$1/application/plant), this product is designed for use in small plantings to provide extended control of disease and/or insects in landscape plantings of vulnerable herbaceous and woody ornamentals. In this study, efficacy of the All-In-One drench was compared with the foliar-applied commercial fungicide Daconil Weather Stik® as well as retail fungicides Immunox® Multi-purpose Fungicide, RosePride® Disease Control Concentrate, and Disease Control for Roses, Flowers & Shrub Concentrate for the control of *Entomosporium* leaf spot in a simulated landscape planting of red tip photinia. Monthly drenches of

All-In-One failed to reduce the severity of *Entomosporium* leaf spot compared to non-fungicide treated controls. Over a 3-year period, the level of leaf spotting and premature defoliation on All-In-One- and non-fungicide treated photinia was similar. In contrast, twice monthly foliar applications of Immunox Multi-purpose Fungicide, RosePride Disease Control Concentrate, Daconil Weather Stik, and Disease Control for Roses, Flowers & Shrub Concentrate, which contains the same tebuconazole active ingredient as All-In-One Rose & Flower Care, controlled *Entomosporium* leaf spot on photinia. Highest level of disease control was obtained with the latter two foliar-applied fungicides.

Introduction

Entomosporium leaf spot, caused by the fungus *Entomosporium mespili* (DC.) Sacc. (= *E. maculatum* Lev., teleomorph *Diplocarpon maculatum* (Atk.) Jorstad), is a common and damaging disease in nursery and landscape plantings of red tip photinia (*Photinia* × *fraseri* 'Birmingham') across the Southern region of the United States. Indian hawthorn, flowering pear, loquat, and other photinia species such as *P. serrulata* and *P. glabra* are other common hosts for this disease (1, 5).

Protective fungicide treatments are often required to maintain the health and beauty of red tip photinia in the landscape. Effective control of *Entomosporium* leaf spot on photinia can be maintained with weekly to twice monthly foliar applications of fungicides such as Zyban WSB (thiophanate-methyl + mancozeb), Daconil Weather Stik® (chlorothalonil), and Eagle® 20E (myclobutanil) (2, 4, 10). When application intervals are extended beyond 2 weeks, the level of Ento-

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mosporium leaf spot control provided by fungicides such as Daconil Weather Stik 6F sharply declines (8).

While a commercial nursery has the personnel and equipment required to maintain a preventative foliar fungicide program for effective disease control, homeowners desire a less time-consuming means of control. Soil drenches of a systemic fungicide are an alternative to foliar-applications for controlling leaf spots and blights in landscape plantings of herbaceous and woody ornamentals. All-In-One Rose & Flower Care (All-In-One) contains the systemic triazole [ergosterol biosynthesis inhibitor (Group 3)] fungicide tebuconazole and is formulated to be applied as a soil drench rather than a foliar spray for the control of leaf spot diseases and blights of flowers, shrubs, and trees. Previously, foliar applications of tebuconazole have been shown to control Entomosporium leaf spot on photinia (2) but not black spot on rose (9). When applied as a soil drench to established roses, several formulations of tebuconazole reduced the severity of black spot (6, 11, 12, 13). However, foliar applications of Daconil Ultrex® proved in a later study superior to most drench rates of tebuconazole for controlling black spot on rose (7). At elevated drench rates of tebuconazole, roses developed deep green leaf color, reduced leaf size, and shortening of the shoot internodes (11), which are plant growth regulator (PGR) symptoms previously associated with the extended use of high rates of a triazole fungicide on container-grown photinia (2).

Performance of drench treatments of All-In-One Rose & Flower Care for the control of Entomosporium leaf spot of photinia has not been evaluated. The objective of this study was to compare the efficacy of drench treatments of All-In-One with twice monthly foliar applications of label rates of home retail fungicide products Disease Control for Roses, Flowers & Shrub Concentrate, Immunox® Multipurpose Fungicide, and RosePride® Disease Control Concentrate as well as the commercial standard Bravo Weather Stik® 6F for the control of Entomosporium leaf spot in a simulated landscape planting of red-tip photinia.

Materials and Methods

Plant culture. In the spring of 2004, 'Birmingham' red-tip photinia (*Photinia × fraseri*) were transplanted from #1 containers into a Benndale fine sandy loam soil ($\leq 1\%$ OM) at the Brewton Agricultural Research Center (USDA Hardiness Zone 8A) in Brewton, AL, on 2 m (6 ft) centers with 3 m (10 ft) between rows. A drip irrigation system was installed at planting and plants were watered as needed. Prior to planting, soil fertility and pH were adjusted according to the results of a soil fertility assay. In February of each year, aged pine bark was evenly distributed around the base of each plant. In late March, 51 g (1.7 oz) of 16N-4P-8K analysis fertilizer or equivalent was evenly distributed around the base of each plant. Pre-emergent weed control was obtained with a broadcast application of 2.2 kg ai-ha⁻¹ (2 qt-A⁻¹) of Surflan (oryzalin, United Phosphorus, 423 Riverview Plaza, Trenton, NJ) + 0.68 kg ai-ha⁻¹ (1.0 lb-A⁻¹) of Gallery (isoxaben, Dow AgroSciences LLC, Indianapolis, IN) on January 30, 2006, February 1, 2007, and March 6, 2008. Escape weeds were hoed or pulled by hand.

Fungicide comparison. The experimental design was a randomized complete block with six single-plant replicates. Drenches of a 1 liter solution of Bayer Advanced™ All-

In-One Rose & Flower Care containing 0.6 g ai-liter⁻¹ of tebuconazole, 0.1 g ai-liter⁻¹ of the insecticide imidacloprid, and 9N-14P-9K analysis fertilizer (8.0 fl oz-gal⁻¹) was poured in a 0.3 m circle around the base of each plant at 4-week intervals between January 4 and July 5, 2006; January 12 and July 11, 2007; and January 17 and June 23, 2008. Immunox® Multi-purpose Fungicide (myclobutanil, Spectracide Products, St. Louis, MO) at 0.16 g ai-liter⁻¹ (1 fl oz-gal⁻¹), Bayer Advanced™ Disease Control for Roses, Flowers & Shrub Concentrate (tebuconazole, Bayer CropScience, Research Triangle Park, NC) at 0.19 g ai-liter⁻¹ (0.75 fl oz-gal⁻¹), Daconil Weather Stik® 6F (chlorothalonil, Syngenta Professional Products, Greensboro, NC) at 1.25 g ai-liter⁻¹ (0.24 fl oz-gal⁻¹), and RosePride® Disease Control Concentrate (triforine, Ortho®, The Scotts Company LLC, Marysville, OH) at 0.25 g ai-liter⁻¹ (0.5 fl oz-gal⁻¹) were applied to the foliage of individual plants to runoff using a CO₂-pressurized sprayer with a hand-held wand with a single adjustable hollow cone nozzle at approximately 2-week intervals during the above calendar period. The non-fungicide treated controls were not sprayed with water. Fertilization rates for the foliar fungicide-treated photinia were not adjusted to account for the fertilizer component of All-In-One Rose & Flower Care.

Disease assessment. Severity of Entomosporium leaf spot was rated using a modified Florida peanut leaf spot scoring system (3) where 1 = no disease, 2 = light leaf spotting in the lower canopy, 3 = light leaf spotting in the lower and upper canopy, 4 = light to moderate leaf spotting with $\leq 10\%$ defoliation, 5 = noticeable leaf spotting in upper canopy with $\leq 25\%$ defoliation, 6 = heavy spotting with $\leq 50\%$ defoliation, 7 = heavy spotting with $\leq 75\%$ defoliation, 8 = numerous spots on few remaining leaves with $\leq 90\%$ defoliation, 9 = very few remaining leaves heavily spotted with $\leq 95\%$ defoliation, and 10 = plants defoliated (100%). Disease ratings were recorded on March 22, May 17, and June 6, 2006; April 2, April 23, May 18, and July 3, 2007; and April 24, May 29, and July 3, 2008.

Area under disease progress curves (AUDPC) for Entomosporium leaf spot were calculated for each year from the Florida leaf spot data (15). Analysis of variance using PROC MIXED procedure in SAS (14) indicated that the year effect was not significant, so AUDPC data were pooled over years. In contrast, the year effect on Florida leaf spot values recorded in May of each study year was significant so subsequent analyses were segregated by year. All statistical analyses on Florida leaf spot and AUDPC values were done on rank transformations of data. For presentation, data are back transformed to AUDPC or Florida leaf spot values. Means were separated using Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Results and Discussion

Average Entomosporium leaf spot AUDPC values for the non-treated control and the All-in-One drench treatments were similar and significantly higher than the foliar-applied fungicides (Fig. 1). Among the foliar-applied fungicides, RosePride provided less overall control of Entomosporium leaf spot than Disease Control, Immunox, and Daconil Weather Stik, which had equally low Entomosporium leaf spot AUDPC values.

While the pooled Entomosporium leaf spot AUDPC values clearly illustrates significant differences in fungicide

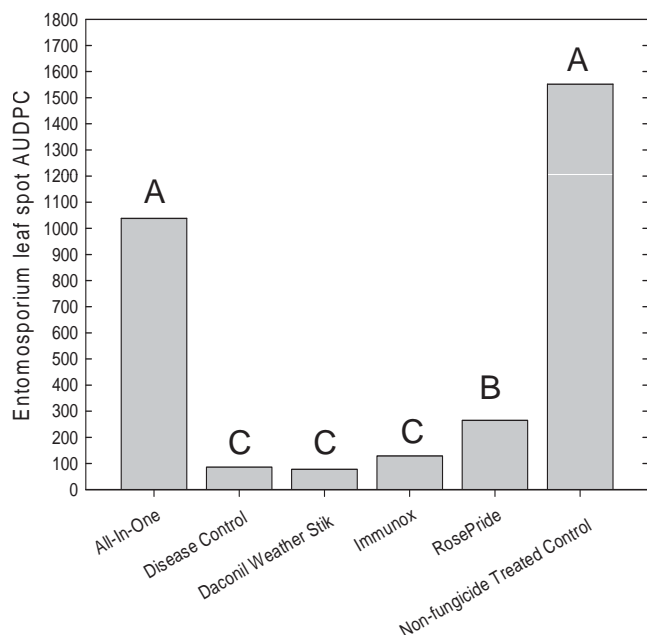


Fig. 1. Area under the disease progress curves (AUDPC) values for *Entomosporium* leaf spot averaged across study years 2006, 2007 and 2008 for foliar-applied fungicides Disease Control, Daconil Weather Stik, Immunox, RosePride, and All-In-One drench in comparison with the non-fungicide treated control. Bars topped by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

efficacy, differences in the level of leaf spotting and premature defoliation attributed to this disease can be compared using the Florida leaf spot scale values recorded in May for each study year. As indicated by disease ratings ranging from 5.0 in 2006 to 6.8 in 2007 (Table 1), the non-treated controls suffered from moderate to heavy leaf spotting as well as defoliation ranging from 25 to nearly 75%. In all study years, *Entomosporium* leaf spot ratings did not differ

between the non-fungicide treated controls and All-In-One-treated photinia.

The poor performance of All-In-One against *Entomosporium* leaf spot on photinia may be rate-related. In Texas studies, drenches of two formulations of tebuconazole, which were applied at the All-In-One rate of 0.6 g ai-liter⁻¹·plant⁻¹ at six-week intervals, proved equally (12) if not more effective (13) than weekly applications of Daconil Ultrex in controlling black spot on the hybrid tea rose 'Peace'. In contrast, drenches of 2.3 and 4.6 g ai-liter⁻¹·plant⁻¹ of tebuconazole, when scheduled at 3- to 4-week intervals controlled black spot on 'Christian Dior' hybrid tea rose as effectively as weekly applications of Daconil Ultrex, while All-In-One at the label 0.6 g ai-liter⁻¹·plant⁻¹ rate failed to check disease spread (6). In an earlier Alabama trial on a field-grown shrub rose, tebuconazole drenches at 4.6 and 6.9 g ai-liter⁻¹·plant⁻¹ made at 6- and 8-week intervals gave equal to or sometimes better black spot control than weekly applications of Daconil Ultrex (11). With elevated drench rates of tebuconazole on roses, however, deep green leaf color, noticeable chlorosis around the leaf margin, reduced leaf area, and shortening of the shoot internodes was occasionally noted (Hagan, personal observation). However, none of the above plant growth regulator (PGR) symptoms were seen on the All-In-One-treated photinia in our study. In a preliminary 2005 trial, the growth index (GI) of the All-In-One-treated photinia exceeded that of the foliar fungicide treated and non-fungicide treated photinia (Hagan, unpublished data). The higher GI was likely due to the All-In-One fertilizer component rather than enhanced disease control.

RosePride gave less control of *Entomosporium* leaf spot in each study year compared with Disease Control and Daconil Weather Stik. As indicated by disease ratings ranging from 1.8 to 3.0, symptoms on the RosePride-treated photinia were restricted to a few scattered spots on the juvenile leaves at the shoot tips without premature defoliation. With the exception of 2007, the level of leaf spotting on the Immunox-treated photinia was intermediate between the level of control obtained with Rose Pride and the other fungicides. In all three years, photinia treated with Disease Control, and Daconil

Table 1. Comparison of All-In-One soil drench and foliar-applied fungicides for the control of *Entomosporium* leaf spot on red tip photinia in May 2006, 2007, and 2008.

Product and rate·liter ⁻¹	Application		Disease rating ^a		
	Placement	Interval	2006	2007	2008
All-In-One 0.6 g ai-liter ^{-1y}	Drench	4 week	3.7a ^w	6.8a	4.8a
Daconil Weather Stik 1.25 g ai-liter ^{-1x}	Foliar spray	2 week	1.0c	1.0c	1.5c
Disease Control 0.19 g ai-liter ^{-1x}	Foliar spray	2 week	1.0c	1.2c	1.3c
Immunox 0.16 g ai-liter ^{-1x}	Foliar spray	2 week	1.3bc	1.2c	2.2bc
RosePride 0.25 g ai-liter ^{-1x}	Foliar spray	2 week	1.8b	2.3b	3.0b
Non-fungicide treated control	—	—	5.0a	6.8a	6.2a

^aEntomosporium leaf spot ratings were recorded on May 17, 2006; May 16, 2007; and May 29, 2008, using a modified 1 to 10 Florida peanut leaf spot rating system.

^yAll-In-One Rose & Flower Care was poured over the soil surface in the root zone at a rate of 1 liter of drench solution per plant where 1 = no disease, 2 = light leaf spotting in the lower canopy, 3 = light leaf spotting in the lower and upper canopy, 4 = light to moderate leaf spotting with $\leq 10\%$ defoliation, 5 = noticeable leaf spotting in upper canopy with $\leq 25\%$ defoliation, 6 = heavy spotting with $\leq 50\%$ defoliation, 7 = heavy spotting with $\leq 75\%$ defoliation, 8 = numerous spots on few remaining leaves with $\leq 90\%$ defoliation, 9 = very few remaining leaves heavily spotted with $\leq 95\%$ defoliation, and 10 = plants defoliated (100%).

^xDaconil Weather Stik, Disease Control for Roses, Flowers & Shrub Concentrate, Immunox Multi-purpose Fungicide, and RosePride Disease Control Concentrate were applied to the foliage to drip.

^wMeans followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Weather Stik had equally low disease ratings. In study years one and two, no symptoms were observed on the Daconil Weather Stik-treated photinia and in study year one with the Disease Control-treated photinia. Previously, foliar applications of Daconil Ultrex or Daconil Weather Stik (2, 4, 10) as well as commercial or experimental formulations that contained the same active ingredient as Immunox (myclobutanil) (2), RosePride (triforine) (4), and Disease Control (tebuconazole) (2) have demonstrated excellent efficacy for the control of *Entomosporium* leaf spot on container grown photinia. While significant reductions in the growth of the container-grown photinia were observed with weekly applications of an experimental formulation of tebuconazole at 0.08 g ai-liter⁻¹ in a previous study (2), no noticeable reduction in shoot growth or other PGR symptoms with this fungicide were observed here on the Disease Control-treated photinia (Hagan, unpublished data).

In summary, the All-In-One Rose & Flower Care drench at label rates proved ineffective in reducing the severity of *Entomosporium* leaf spot on photinia. While increasing the All-In-One drench rate may result in more efficacious control of *Entomosporium* leaf spot, the risk of PGR-related plant injury may be greatly increased. In contrast, the foliar-applied retail fungicides Immunox, RosePride, and Disease Control as well as the commercial fungicide Daconil Weather Stik when applied every two weeks gave superior disease control.

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