Environment Horticulture Program Research Summaries

IR-4 Environmental Horticulture Program
Algal Leaf Spot Efficacy & Literature Review

Cephaleuros virescens

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Acknowledgements
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Abstract

At the IR-4 Environmental Horticulture Program Workshop in 2015, Algal Leaf Spot Efficacy was selected as a regional special project for the Southern Region to determine the efficacy of several fungicides for this disease. Eleven products representing 10 active ingredients were tested as foliar applications against *Cephaleuros virescens* causing algal leaf spot on southern magnolia. Two of the products tested were copper fungicides recommended for management of algal leaf spot. Although there were insufficient IR-4 data for definitive conclusions, two relatively new products that are included in this research project, KleenGrow and Mural, provided efficacy comparable to COC DF, the top performing copper fungicide in the trials.

Introduction

Algal leaf spot is a foliar disease, caused by a parasitic alga (*Cephaleuros virescens*) that occurs primarily in the southeastern states where it may be a common sight on southern magnolia (*Magnolia grandiflora*) and common camellia (*Camellia japonica*) growing in humid, warm weather climates. When disease pressure is high, copper fungicides are the recommended products to manage this disease.

At the IR-4 Environmental Horticulture Program Workshop in 2015, Algal Leaf Spot Efficacy was selected as a regional special project for the Southern Region to determine the efficacy of several fungicides for this disease. Eleven products representing 10 active ingredients were tested as foliar applications against *Cephaleuros virescens* causing algal leaf spot on southern magnolia. Two of the products tested were copper fungicides recommended for management of algal leaf spot. This report is a brief summary of available data from 2 experiments in 2017 received from the IR-4 Environmental Horticulture Program.

Materials and Methods

In 2017, eleven products representing 10 active ingredients were tested as foliar applications against naturally occurring infections of *Cephaleuros virescens* causing algal leaf spot on southern magnolia. Two of the products tested were copper fungicides recommended for management of algal leaf spot. The researcher used 6 replications. Disease severity and incidence were recorded at various intervals after initial application. Phytotoxicity or lack of it was generally noted in the reports. Dr. Fulya Baysal-Gurel conducted the tests (Appendix 1).

Products were supplied by their respective manufacturers.

For IR-4 testing, the following protocols were used: 16-016 and 17-016. Please visit https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols to view and download these protocols.

For all research data tables, product names have been updated where manufacturers have established trade names, and tables have been rearranged by product alphanumeric order.

Table 1. List of Products and Rates Tested on Environmental Horticulture Crops in 2017.

Active Ingredient(s)	Product(s)	Manufacturer	Rate(s) Tested		# Trials
Azoxystrobin + Benzovindiflupyr	Mural WDG	Syngenta	Foliar	7 oz per 100 gal	2
Bacillus amyloliquefaciens strain D747	Double Nickel LC	Certis	Foliar	4 qt per 100 ga	2
Chlorothalonil	Daconil Ultrex	Syngenta	Foliar	1.2 lb per 100 ga	2
	Daconil Weatherstik			20 fl oz per 100 gal	2
Copper octanoate	Camelot O	SePRO	Foliar	1 gal per 100 gal	2
Copper oxychloride	COC DF	Albaugh	Foliar	1 lb per 100 gal	2
Didecyl dimethyl ammonium chloride	KleenGrow	Pace	Foliar	25 fl oz per 100 gal	2
Hydrogen dioxide + Peroxyacetic acid	ZeroTol 2.0	BioSafe	Foliar	2 gal per 100 gal	2
Mono- and di-potassium salts of phosphorus acid + Hydrogen peroxide	OxiPhos	BioSafe	Foliar	2 gal per 100 gal	2
Potassium bicarbonate	Milstop	BioWorks	Foliar	2.5 lb per 100 gal	2
Sodium carbonate peroxyhydrate	GC Pro	BioSafe	Foliar	4 lb per 100 gal	2

Results

Comparative Efficacy for Cephaleuros virescens

In 2017, Baysal-Gurel conducted 2 experiments to examine the activity of chemical and biologically-based tools for naturally occurring *Cephaleuros virescens* infections on southern magnolia. In the first experiment, fungicides were applied as foliar sprays from Jul 19 to Aug 2 as shown in the Table 2; in the second, fungicides were applied from Aug 22 to Sep 5 as shown in Table 3. In both trials, phytotoxicity, chlorosis, defoliation, discoloration and stunting were not observed in any of the treated plants.

In the first experiment, the final disease pressure was low with a severity mean value was 3.7% in the non-treated control magnolia plants. All fungicide treatments significantly reduced algal leaf spot severity and disease progress compared to non-treated control (Table 2). Final disease severity ratings in Camelot O, COC DF, Daconil Ultrex, Daconil Weather Stik, Mural, OxiPhos, ZeroTol 2.0 and KleenGrow treated magnolia plants were statistically comparable to those treated with Double Nickel LC, Milstop and GC Pro. Camelot O, COC DF, Daconil Ultrex, Daconil Weather Stik, Mural and KleenGrow were more effective in reducing disease progress (AUDPC) than Double Nickel LC, Milstop, GC Pro, OxiPhos and ZeroTol 2.0.

In the second experiment, algal leaf spot infections was moderate, with the final disease severity mean value was 34.6% in the non-treated control magnolia plants. All fungicide treatments significantly reduced algal leaf spot severity and disease progress compared to non-treated control (Table 3). Final disease severity ratings in Mural, COC DF and KleenGrow treated magnolia plants were statistically comparable to those treated with Daconil Ultrex, Daconil Weather Stik, Camelot O, GC Pro, Double Nickel LC, Milstop, OxiPhos and ZeroTol 2.0. Mural, COC DF and KleenGrow were more effective in reducing disease progress (AUDPC) than the foliar application of other treatments as well.

Table 2. Efficacy for *Cephaleuros virescens* on Southern Magnolia (*Magnolia grandiflora*), Baysal-Gurel, TN, 2017, Test 1.

Treatment	Rate Per 100 Gal	Applic. Dates	% Algal Leaf Spot (8/23)	AUDPC	Initial Plant Ht (cm)	Final Plant Ht (cm)	Initial Plant Width (cm)	Final Plant Width (cm)
Camelot O (copper octanoate)	1 gal	1,2,3	0.0 e	0.0 e	41.3 a	54.8 abc	26.7 a	37.1 a
COC DF (copper oxychloride)	1 lb	1,2,3	0.0 e	0.0 e	40.2 a	57.0 ab	27.8 a	36.4 a
Daconil Ultrex (chlorothalonil)	1.2 lb	1	0.0 e	0.0 e	38.7 a	54.7 bcd	26.8 a	35.3 ab
Daconil Weather Stik (chlorothalonil)	20 fl oz	1	0.0 e	0.0 e	36.8 a	52.8 cd	27.1 a	36.1 a
Double Nickel LC (*Bacillus amyloliquefaciens* strain D747)	4 qt	1,2,3	1.1 bc	10.2 b	37.3 a	55.2 abc	28.0 a	36.3 a
GC Pro (sodium carbonate peroxyhydrate)	4 lb	1,2,3	0.6 cd	4.9 c	37.0 a	55.8 abc	26.8 a	35.4 ab
KleenGrow (didecyl dimethyl ammonium chloride)	25 fl oz	1,3	0.0 e	0.0 e	37.5 a	56.7 ab	27.0 a	34.5 ab
Milstop (potassium bicarbonate)	2.5 lb	1,2,3	1.4 b	11.4 b	36.8 a	56.8 ab	28.0 a	36.4 a
Mural (azoxystrobin + benzovindiflupyr)	7 oz	1,2,3	0.0 e	0.0 e	37.3 a	58.0 a	27.9 a	36.1 a
OxiPhos (mono- and di-potassium salts of phosphorus acid + hydrogen peroxide)	2 gal	1,2,3	0.3 de	1.5 cd	37.2 a	54.2 bcd	26.9 a	36.5 a
Zerotol 2.0 (hydrogen dioxide + peroxyacedic acid)	2 gal	1,2,3	0.1 de	0.9 cd	36.0 a	54.5 bcd	25.6 a	33.0 b
Untreated control	-	-	3.7 a	44.3 a	37.2 a	51.5 d	25.8 a	33.2 b

[x] Means followed by same letter do not differ significantly based on Fisher's least significant difference test (P=0.05).

[y] Application dates for treatments were: 1 = Jul 19; 2 = Jul 26; 3 = Aug 2.

Table 3. Efficacy for *Cephaleuros virescens* on Southern Magnolia (*Magnolia grandiflora*), 'Jane' Baysal-Gurel, TN, 2017, Test 2.

Treatment	Rate Per 100 Gal	Applic. Dates	% Algal Leaf Spot (9/19)	AUDPC	Initial Plant Ht (cm)	Final Plant Ht (cm)	Initial Plant Width (cm)	Final Plant Width (cm)
Camelot O (copper octanoate)	1 gal	1,2,3	14.2 f	269.8 e	198.3 a	201.3 a	120.4 a	127.9 a
COC DF (copper oxychloride)	1 lb	1,2,3	7.9 h	177.9 gh	200.8 a	202.8 a	133.3 a	141.3 a
Daconil Ultrex (chlorothalonil)	1.2 lb	1	11.3 g	218.8 fg	206.7 a	210.0 a	140.8 a	151.7 a
Daconil Weather Stik (chlorothalonil)	20 fl oz	1	15.4 f	288.8 e	193.3 a	196.7 a	137.5 a	145.8 a
Double Nickel LC (*Bacillus amyloliquefaciens* strain D747)	4 qt	1,2,3	23.8 c	370.4 bc	196.7 a	199.2 a	130.4 a	138.3 a
GC Pro (sodium carbonate peroxyhydrate)	4 lb	1,2,3	14.2 f	224.6 f	197.5 a	200.8 a	121.7 a	127.9 a
KleenGrow (didecyl dimethyl ammonium chloride)	25 fl oz	1,3	8.8 h	170.6 h	195.8 a	199.2 a	124.2 a	134.2 a
Milstop (potassium bicarbonate)	2.5 lb	1,2,3	27.9 b	408.3 b	185.8 a	190.0 a	130.8 a	140.4 a
Mural (azoxystrobin + benzovindiflupyr)	7 oz	1,2,3	7.5 h	161.9 h	191.7 a	194.2	132.9 a	140.0 a
OxiPhos (mono- and di-potassium salts of phosphorus acid + hydrogen peroxide)	2 gal	1,2,3	20.8 d	348.5 cd	199.2 a	203.3 a	140.0 a	151.3 a
Zerotol 2.0 (hydrogen dioxide + peroxyacedic acid)	2 gal	1,2,3	17.5 e	307.7 de	199.2 a	203.3 a	126.3 a	137.9 a
Untreated control	-	-	34.6 a	533.8 a	195.8 a	199.2 a	133.3 a	140.0 a

[x] Means followed by same letter do not differ significantly based on Fisher's least significant difference test (P=0.05).

[y] Application dates for treatments were: 1 = Aug 22; 2 = Aug 29; 3 = Sep 5.

Efficacy Summary by Product/Active Ingredient

A brief efficacy summary for select products is given below, with a reminder that there are very limited data available to draw definitive conclusions. Products were selected based on interest in these products for testing in 2016 and 2017 Regional Algal Leaf Spot efficacy projects.

Azoxystrobin + Benzovindiflupyr. In 2 magnolia experiments, Mural provided 100% efficacy for a low disease pressure of *Cephaleuros virescens* and good efficacy for a moderate disease pressure. It was one of three best treatments.

Bacillus amyloliquefaciens strain D747. In 2 magnolia experiments, Double Nickel LC provided mediocre efficacy for a low disease pressure of *Cephaleuros virescens* and poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Chlorothalonil. In 2 magnolia experiments, Daconil Ultrex and Daconil Weather Stik provided 100% efficacy for a low disease pressure of *Cephaleuros virescens*, but mediocre and poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Copper octanoate. In 2 magnolia experiments, Camelot O provided 100% efficacy for a low disease pressure of *Cephaleuros virescens*, but poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Copper oxychloride. In 2 magnolia experiments, COC DF provided 100% efficacy for a low disease pressure of *Cephaleuros virescens* and good efficacy for a moderate disease pressure. It was one of three best treatments.

Didecyl dimethyl ammonium chloride. In 2 magnolia experiments, KleenGrow provided 100% efficacy for a low disease pressure of *Cephaleuros virescens* and good efficacy for a moderate disease pressure. It was one of three best treatments.

Hydrogen dioxide + Peroxyacetic acid. In 2 magnolia experiments, ZeroTol 2.0 provided 100% efficacy for a low disease pressure of *Cephaleuros virescens*, but poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Mono- and di-potassium salts of phosphorus acid + Hydrogen peroxide. In 2 magnolia experiments, OxiPhos provided great efficacy for a low disease pressure of *Cephaleuros virescens*, but poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Potassium bicarbonate. In 2 magnolia experiments, Milstop provided mediocre efficacy for a low disease pressure of *Cephaleuros virescens* and poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Sodium carbonate peroxyhydrate. In 2 magnolia experiments, GC Pro provided good efficacy for a low disease pressure of *Cephaleuros virescens*, but poor efficacy for a moderate disease pressure. It was inferior to copper oxychloride, one of three best treatments.

Phytotoxicity

No phytotoxicity to magnolia was observed with the products listed above.

Table 4. Summary of product efficacy by crop.

Note: Table entries are sorted by product, pathogen Latin name, and then by crop Latin name. Only those IR-4 trials received by 3/15/2019 are included in the table below.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
32930	Camelot (Copper salts of fatty and rosin acids)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 1 gal per 100 gal applied 3 times; inferior to the most effective treatments.
32930	Camelot (Copper salts of fatty and rosin acids)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 1 gal per 100 gal applied 3 times.
32931	COC DF (Copper oxychloride)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia, Southern (Magnolia grandiflora) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 1 lb per 100 gal applied 3 times; one of 3 most effective treatments.
32931	COC DF (Copper oxychloride)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia, Southern (Magnolia grandiflora) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 1 lb per 100 gal applied 3 times.
32932	Daconil Ultrex (Chlorothalonil)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 1.2 lb per 100 gal applied once; inferior to the most effective treatments.
32932	Daconil Ultrex (Chlorothalonil)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 1.2 lb per 100 gal applied once.
32933	Daconil Weather Stik (2787 Flowable Fungicide) (Chlorothalonil)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 20 fl oz per 100 gal applied once; inferior to the most effective treatments.
32933	Daconil Weather Stik (2787 Flowable Fungicide) (Chlorothalonil)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 20 fl oz per 100 gal applied 3 times.
32934	Double Nickel LC (Bacillus amyloliquefaciens Strain D747)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 4 qt per 100 gal applied 3 times; inferior to the most effective treatments.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
32934	Double Nickel LC (Bacillus amyloliquefaciens Strain D747)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2016	Foliar	Mediocre control of a low disease pressure with 4 qt per 100 gal applied 3 times.
32935	GC Pro (TerraCyte Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 4 lb per 100 gal applied 3 times; inferior to the most effective treatments.
32935	GC Pro (TerraCyte Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Good control of a low disease pressure with 4 lb per 100 gal applied 3 times.
33501	Kleengrow (Didecyl dimethyl ammonium chloride)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 25 fl oz per 100 gal applied twice; one of 3 most effective treatments.
33501	Kleengrow (Didecyl dimethyl ammonium chloride)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 25 fl oz per 100 gal applied twice.
32936	MilStop (Potassium bicarbonate)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 2.5 lb per 100 gal applied 3 times; inferior to the most effective treatments.
32936	MilStop (Potassium bicarbonate)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Mediocre control of a low disease pressure with 2.5 lb per 100 gal applied 3 times.
32937	Mural WDG (Azoxystrobin + benzovindiflupyr)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 7 oz per 100 gal applied 3 times; one of 3 most effective treatments.
32937	Mural WDG (Azoxystrobin + benzovindiflupyr)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	100% control of a low disease pressure with 1 lb per 100 gal applied 3 times.
32938	OxiPhos (Mono and di potassium salts of phosphorus acid + hydrogen peroxide)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 2 gal per 100 gal applied 3 times; inferior to the most effective treatments.
32938	OxiPhos (Mono and di potassium salts of phosphorus acid + hydrogen peroxide)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Excellent control of a low disease pressure with 2 gal per 100 gal applied 3 times.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
32939	ZeroTol 2.0 (Hydrogen dioxide + peroxyacetic acid)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Jane'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Significantly reduced moderate severity and disease progress with 2 gal per 100 gal applied 3 times; inferior to the most effective treatments.
32939	ZeroTol 2.0 (Hydrogen dioxide + peroxyacetic acid)	Algal Leaf Spot (Cephaleuros virescens)	Magnolia (Magnolia sp.) 'Southern'	Field In-Ground	Baysal-Gurel	TN	2017	Foliar	Excellent control of a low disease pressure with 2 gal per 100 gal applied 3 times.

Appendix 1: Contributing Researchers

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