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Factors Affecting Fungicidal Control of Entomosporium Leaf Spot of Photinia[1]

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Abstract

Entomosporium leaf spot of photinia (*Photinia* × *fraseri* Dress) was epidemic throughout most of Georgia and much of the Southeast during the spring of 1991. It has been endemic for many years. The relatively high minimum temperatures recorded in December–March 1990–91 in concert with 52 days of rain during this period were conducive to disease development. Currently recommended fungicides are effective for control if they are applied on a weekly basis. Newer fungicides were effective against the fungus in laboratory culture, but labels are not approved for application to landscape or nursery plants. Spray nozzle types (flat or full cone) delivering 5 to 7 ml per second of fungicide were as effective for disease control as spray nozzles delivering four to five times more volume.

Index words: *Photinia* × *fraseri, Entomosporium mespili*, red-tip photinia, fungicides, benomyl, chlorothalonil

Significance to the Nursery Industry

The recent increased incidence and severity of photinia leaf spot in the Southeast may be attributed to mild, rainy winter months. The outbreak in 1991 certainly created a greater public awareness of the disease and raised questions about the future use of this plant in landscape plantings. The research described suggests several approaches for disease control, including the timing and frequency of fungicide applications, effect of lower spray volumes, and the activity of fungicides against the causal fungus in laboratory tests. Nurserymen should make every effort to control the disease before the point of sale by monitoring disease incidence relative to weather conditions and applying most effective fungicides early and frequently enough to minimize disease development.

Introduction

Severe leaf-spotting and defoliation of two Photinia species, *P. glabra* (Thunb.) Franch. & Sav. and *P. serrulata* (Desf.) Kalkman (= *P. serrulata* Lindl.), were reported in Louisiana as early as 1957 (21). The causal fungus was identified as an Entomosporium indistinguishable from *Entomosporium maculatum* Lév. (*Fabraea maculato* (Lév.) Atk.), the cause of pear and quince leaf blight. It is also known to occur on other hosts (18, 19). The anamorphic stage has been named *E. mespili* (DCex Dirby) Sacc. (10).

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Entomosporium leaf spot has become widespread in the Southeast, especially on *Photinia* × *fraseri* Dress., a cross between *P. glabra* and *P. serrulata* (20), which has been widely marketed and planted during the last two decades. During the spring of 1991, the disease was epidemic throughout Georgia, causing considerable concern for homeowners and landscapers. A major Atlanta TV station even covered the ''blight'' on primetime newscasts.

A considerable amount is known about the etiology of the disease (15, 16), the effect of leaf age (1), temperature, and wetness (2) on infection and the efficacy of various fungicidal sprays (3, 4, 11–14, 17). However additional information is needed if the grower is to economically produce a healthy plant under intense disease pressure.

The purposes of our research were to determine if certain weather factors were conducive for the recent leaf spot outbreaks; to determine if different spray nozzles and pressures would enhance disease control (23); to establish the optimum fungicide application frequency; and to ascertain the effectiveness of newer fungicides to inhibit fungal growth *in vitro*.

Materials and Methods

The amount of rainfall and minimum and maximum temperature records at the Georgia Station weather station over the past 8 years were examined for the months of December, January, February, and March. The number of days with measured rain as well as those with any trace of rainfall during this same period were noted. Notes on the degree of Photinia leaf spot disease were available for 1983, 1984, 1987, and 1991 (4 of the past 8 years).

To evaluate efficacy of a currently recommended fungicide in diminishing defoliation associated with severe leaf spot infection, an established photinia planting [(3.6 m (10 ft) ht] at the Georgia Station was sprayed three times in 1983 (February 23, March 29, and April 28) with maneb (Manzate), at the rate of 908 grams formulated/100 gallons. The fungicide was applied, using a hand-held 11.3 l (3 gal) sprayer, to the upper and lower leaf surfaces to the point of runoff. Approximately 15 m (49 linear ft) of the planting was sprayed; 15 m was not sprayed. Leaves from unsprayed and sprayed plants were collected on April 1 and examined for fungal sporulation. Their conidia were removed and incubated overnight in sterile distilled water droplets at laboratory temperature, and conidial germination was determined after 24 hours.

Four different Spraying Systems® nozzles were selected to determine if the spray pattern in conjunction with two sprayer pressures would affect disease control on container grown photinia. Each nozzle-pressure combination was used on three replications, consisting of 6 naturally infected plants. Using the fungicide benomyl (Benlate 50WP), two flat pattern spray nozzles (Spraying Systems Nos. 8008 and 80015) and two full-cone pattern nozzles (Nos. TG 3.5 and TG 0.7) were selected for use at 2 pressure ranges, 12–16 and 20–22 psi. After determining the volume delivered by each nozzle at a given pressure and the amount of time needed to adequately cover the foliage of 6 plants, the amount of fungicide was calculated to provide the same amount applied regardless of nozzle type–pressure combination. Nine weekly applications with each pressure–nozzle pattern combination were made beginning on April 16, 1987. Leaf spot severity was determined on May 18, June 8, June 14, and August 17, using a rating system of 0 = no leaf spots; 1 = fewer than 10% of leaves with spots; 2 = 10 to 50% of leaves with spots; 3 = more than 50% of leaves with spots; and 4 = no leaves present (total abscission).

The experiment was repeated in 1988 using weekly applications of chlorothalonil (Daconil 2787 75WP) instead of benomyl beginning April 20. The number of spots observed on new leaves of each plant was recorded on two dates, June 13 and July 13. Spray distribution patterns for each nozzle type were examined by using Ciba-Geigy water sensitive paper.

In 1989, three fungicides were applied to diseased photinia on either a weekly, biweekly, or triweekly schedule using the Spraying Systems nozzle number 80015 and 20–22 psi. The fungicides and rates were as follows: chlorothalonil (Daconil 2787), 75% wp, 6.8 g/gal (1.5 lbs/100 gal); benomyl (Benlate), 50% wp, 2.3 g/gal (0.5 lb/100 gal); and triforine (Funginex), 4.5 g/gal (1.0 lb/100 gal). The design was a randomized block with 3 replications of 3 plants in each. The number of lesions on 5 leaves of each plant was counted on two dates, May 10 and June 23, 1989. The mean percentage disease control (MPDC) was calculated (see footnote in Table 4).

In vitro fungicide trials against *E. mespili* were carried out using currently recommended and unregistered materials. The objective was to determine the minimum effective fungicide dosage for complete inhibition of fungal growth. Eleven fungicides were tested by adding decreasing concentrations from 40 to 1800 ppm to potato dextrose agar (Difco, Detroit, MI) following autoclaving, incubating the fungus-inoculated plates at 28 C, then measuring the diameter of fungal growth after 7 days. The percentage growth inhibition and standard deviation were calculated, based on the mean of 15 to 20 plates at each fungicide concentration.

Results and Discussions

There were several weather factors during the past 8 years which appear to have been conducive for leaf spot epidemics. When the minimum temperatures for the months of December, January, February, and March were averaged for this period, the minimum temperature during each of last 3 years was greater than the mean of the last 8 by 2.6, 3.1, and 7.5% respectively (Table 1). Prior to 1987–88 the average minimum temperatures for these months were always less or the same as the average for the last 8 years.

Regarding the total number of days with traces of, or measured amounts of rainfall, four months during 1990–91 had the greatest number (52), exceeding the 8 year average by 12 days. The total rainfall received [47 cm (18 in)] was only the fourth highest amount, being exceeded by the 1989–90, 1983–84, and 1986–87 amounts. Personal notes in files on photinia leaf spot occurrence indicate this disease was severe in each spring in 1984 and 1987. An examination of weather records of these four months revealed 50 and 38 days with rain in 1983–84 and 1986–87, respectively. Precipitation totals were 53.3 cm (20.9 in) and 50.1 cm (19.7 in) for these same months.

Excellent leaf spot control was obtained with 3 sprays of maneb (Manzate) fungicide applied in 1983 to a Georgia Station photinia planting. The unsprayed control plants were severely defoliated by May, whereas the sprayed plants held their leaves throughout the season.

Conidia collected April 1 from acervuli on leaves from

Table 1. Average maximum and minimum temperatures and rainfall information covering December, January, February and March (121 days) during the last 8 years.

Year	Dec–March Temp °C(°F) Max	Min	Δ[z]	Dec–March Rainfall[y] Cm (In)	No. days (meas.)	No. days (trace)
1983–84	13.3 (55.9)	0.9 (33.6)	12.4 (22.6)	53.26 (21.0)	42	7
1984–85	14.9 (58.8)	2.2 (35.9)	12.7 (22.9)	39.80 (15.7)	32	2
1985–86	14.9 (58.8)	1.6 (34.9)	13.3 (23.9)	22.68 (8.9)	27	6
1986–87	11.5 (52.7)	2.1 (35.8)	9.4 (16.9)	50.06 (19.7)	38	0
1987–88	13.7 (56.7)	0.9 (33.6)	12.8 (23.1)	33.15 (13.1)	28	3
1988–89	15.6 (60.1)	2.6 (36.1)	13.0 (24.0)	24.74 (9.7)	31	10
1989–90	15.2 (59.4)	2.7 (36.9)	12.5 (22.5)	63.17 (24.9)	41	4
1990–91	14.8 (58.6)	3.6 (38.5)	11.2 (20.1)	47.07 (18.5)	36	16
μ	14.2 (57.6)	2.1 (35.7)	12.2 (22.0)	41.74 (16.4)	34.4	6
±SD	1.3 (2.26)	0.9 (1.5)	1.2 (2.2)	13.32 (5.3)	5.4	4.8

[y]Rainfall in total centimeters (in) for 4 months, number of days with measurable amounts, and number of days with only trace amounts recorded.
[z]Δ = difference between average monthly maximum and average minimum temp °(°F).

these sprayed and unsprayed plants did not germinate within 24 hours in free water on a glass slide at room temperature. Conidia from sprayed leaves had granular cytoplasm, whereas those from unsprayed leaves were well-nucleated and appeared normal. Conidial production and sporulation on photinia leaves following fungicide application needs to be examined as has been done with Indian hawthorne (5–7).

All nozzle types, at both tank pressures, using benomyl weekly from April 16 through June 26, resulted in a significant decrease of photinia leaf spot rating from the unsprayed controls in 1987 (Table 2). Pressure had little effect except that the plants sprayed with 8008 flat nozzle at 12–16 psi had a significantly lower disease rating than plants sprayed with this nozzle at the higher pressure. The spray pattern formed on the water sensitive paper by nozzles 80015 flat and TG 0.7 full cone were almost identical at both pressure ranges. Both resulted in an evenly distributed fine droplet pattern, whereas the pattern with 8008-flat and TG 3.5 full cone, having greater delivery volumes, resulted in a solid pattern of coalesced droplets. There was no statistical difference between nozzle types and pressure on mean number of leaf spots when chlorothalonil was applied weekly from April 20 through July 7, 1988. All resulted in significantly fewer leaf spots than the unsprayed controls (Table 2).

One aspect that must be taken into consideration when spraying large numbers of photinia is the cost of fungicide. The spray nozzle type/pressure combination influences the amount of fungicide delivered to the plants, therefore a comparison of these costs is provided in Table 3. Although fungicide costs may be reduced by approximately one-third and environmental impact lessened with the choice of lower volume nozzles, this must be weighed against the additional time required for spraying and longer exposure to the operator.

Benomyl or chlorothalonil applied at recommended rates, provided satisfactory photinia leaf spot control in 1989 when applied either weekly, every 2 weeks, or every 3 weeks (Table 4). This control was particularly evident at the first evaluation date. By the second evaluation date (June 23rd), 7 or 8 weeks after discontinuing the sprays, the applications made at 2 or 3 week intervals were not as effective as those made weekly. Triforine at the recommended rate was less effective than chlorothalonil or benomyl and resulted in no control when applied only once every 3 weeks.

Table 2. Photinia Leaf Spot Rating (1987) and number of leaf spots (1988) after fungicide sprays with different spray nozzles at two tank pressures.

Tank Pressure	Nozzle Type (Sprayer Systems No)	Leaf Spot Rating[z] Benomyl	Mean No. of Spots[y] Chlorothalonil
12–16 PSI	8008-Flat	1.17 d	10.0 b
	TG 3.5-Full Cone	1.83 bc	7.3 b
	80015-Flat	1.42 cd	10.3 b
	TG 0.7-Full Cone	1.25 d	9.5 b
20–22 PSI	8008-Flat	2.00 b	11.3 b
	TG 3.5-Full Cone	1.58 bcd	15.0 b
	80015-Flat	1.17 d	1.3 b
	TG 0.7-Full Cone	1.17 d	7.2 b
	Control	3.00 a	249.2 a

[z]Rating based on 0 = no leafspots, 1 = fewer than 10% of leaves with spots, 2 = 10 to 50% of leaves with spots, 3 = more than 50% of leaves with spots, and 4 = no leaves present. Average of data taken on 4 dates (5/18, 6/8, 6/24, & 8/17) from 3 replicates with 6 plants each. Ratings with the same letters not statistically different at $P = 0.05$.

[y]Mean number of leaf spots present on 2 young leaves of 18 plants after 11 weekly sprays of Daconil. Data recorded on 6/13 and 7/13. Numbers with same letters are not different statistically at $P = 0.05$.

Table 3. Comparison of Spraying System® nozzle volumes and cost of fungicide delivered for 3 gal. container Photinia plants in 1987 and 1991 using two pressures.

Pressure	Spraying Systems Nozzle-Type	Approx. Vol. del./sec	Cost ($) of Fungicide/100 plants[z] Benomyl 1987	Benomyl 1991	Chlorothalonil 1987	Chlorothalonil 1991
12–16 PSI	8008-Flat	28 ml	0.27	0.36	0.45	0.56
	TG 3.5-Full Cone	24 ml	0.23	0.30	0.38	0.47
	80015-Flat	6 ml	0.10	0.13	0.17	0.21
	TG 0.7-Full Cone	5 ml	0.08	0.11	0.14	0.17
20–22 PSI	8008-Flat	38 ml	0.36	0.48	0.60	0.75
	TG 3.5-Full Cone	31 ml	0.30	0.40	0.56	0.63
	80015-Flat	7 ml	0.12	0.16	0.20	0.25
	TG 0.7-Full Cone	7 ml	0.11	0.15	0.19	0.23

[z]Cost, excluding labor, based on retail prices of $12.75 and $16.87 per pound for Benlate (benomyl) in 1987 and 1991, respectively, and on $7.00 and $8.48 per pound for Daconil (chlorothalonil), using 0.5 pound Benlate and 1.5 pounds Daconil per 100 gallons water as recommended by College of Agriculture, Extension Service, University of Georgia. Volume delivered based on repeated trials from new nozzles at given pressures.

Table 4. Mean percentage disease control of photinia leaf spot in 1989 using Spraying Systems Nozzle 80015 (flat pattern) at 20–22 psi with three fungicides at three application schedules.

Fungicide (Rate)	Evaluation date[z]	MPDC[y] Weekly (10)[x]	Every 2 weeks (6)	Every 3 weeks (4)
Chlorothalonil	5/10	100	100	99
(1.5 lbs/100 gal)	6/23	99	74	68
Benomyl	5/10	100	99	99
(0.5 lbs/100 gal)	6/23	92	63	76
Triforine	5/10	100	60	50
(1.0 lbs/100 gal)	6/23	53	31	2

[z]Evaluation dates: 5/10/89 and 6/23/89 when last sprays applied on 4/26 for weekly, 5/3 for 2 week intervals, and 4/26 for 3 week intervals. Counted number lesions on 5 leaves on each of 3 plants on each evaluation date.

[y]Mean percentage disease control (MPDC) = Mean number lesions in check minus mean number lesions in treatment divided by mean number lesions in check × 100.

[x]Total number of applications.

All fungicides tested, when incorporated into potato dextrose culture medium at rates equivalent to those applied as sprays, were inhibitory to *E. mespili*. Six of 11 fungicides completely inhibited colony growth at concentrations ranging from 50 to 1800 ppm; the fungus grew to a very limited extent with the other 5 materials (Table 5). Benomyl, procloraz, and thiophanate-methyl were completely inhibitory at 40–50 ppm, the lowest concentrations tested. Procloraz is not labeled for use on photinia at present.

The following fungicides are listed for use on photinia in the 1991 Georgia Pest Control Handbook, Special Bulletin 28: Benlate 50DF, Bayleton, Daconil 2787, Dithane F-45, Funginex, FungoFlo, Manzate 200 DF, Manzate 200 WP, Rubigan A.S., Topsin M 4.5F, and Zyban 75 WP. The other fungicides used in these studies should be evaluated under field conditions, and must receive an approved label before being recommended for use on photinia.

Excellent control of photinia leaf spot can be achieved with a variety of fungicides. When the first spray was applied in mid-February, prior to new plant growth, the results were dramatic with little defoliation during the season.

For effective disease control, closer attention should be given to the temperatures and number of rainy days during December, January, February, and March in order to anticipate the leaf spot incidence in this latitude. Records suggest that leaf spot will be above average when 45 to 50 days of rain occurs during this period. When these conditions exist along with warmer than average winter temperatures, then leaf spot could be expected to be worse than normal.

The nozzle types and sprayer pressures had little effect on the number of leaf spots as determined with two different fungicides. Although we tested only 4 nozzles at two pressures, and adjusted rates in order that the same amount of fungicide was applied, no statistical differences in number of leaf spots or ratings occurred using the different nozzle types. Less volume was just as effective as nozzles delivering greater volumes.

Weekly applications of approved (recommended) fungicides were more effective than applications every 2 or 3 weeks when applications began in February and evaluations were made in late June. When evaluations were made in early May, those sprays applied every 2 or 3 weeks were just as effective as those applied weekly, particularly with benomyl or chlorothalonil. The total fungicide applied on a weekly basis exceeded the concentrations of bi- or tri weekly applications and the residue probably resulted in longer lasting fungicidal effects.

Newer fungicides are inhibitory to *Entomosporium mespili* in culture at very low concentrations. How effective they will be when applied to photinia plants must await results of field experiments.

Table 5. Percent inhibition of Entomosporium fungus in fungicide amended media after 7 days growth at 28 C (82°F).

Fungicide	Formulation	Range Rates Tested (mg[z]/L)	Dia ± S.D. (mm)	Inhibition (%)
Triadimefon	Bayleton 50% WP	300	0.0	100.
		160	2.1 ± 2.0	98.
Benomyl	Benlate 50% WP	40–500	0.0	100.
Chlorothalonil	Daconil 2787 75% WP	1800	1.0 ± 1.9	94.
		900	11.9 ± 4	82.
Dithianon	Dithianon 75% WP	700	0.0	100.
		340	8.8 ± 1.9	86.
		170	19.5 ± 2.7	69.
Mancozeb	Fore 80% WP	460–1800	0.0	100.
		240	5.9 ± 1.4	91.
Triforine	Funginex 6.5% EC	4 ml	3.0 ± 3.4	96.
		2 ml	10.9 ± 2.9	85.
Vinclozolin	Ornalin 50% WP	880	12.7 ± 1.9	81.
Procloraz	Procloraz 50% WP	50–200	0.0	100.
		30	0.7 ± 0.7	99.
Iprodione	Rovral 50% WP	2300	1.4 ± 2.0	98.
		1200	4.8 ± 3.6	93.
Fenarimol	Rubigan A.S. 11.6% EC	0.4 ml	4.2 ± 4.2	94.
Thiophanatemethyl	Topsin M 70% WP	40–600	0.0	100.

[z]Amount of formulated fungicide added to potato dextrose agar after autoclaving.

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