Management of Blackspot of Rose in the Landscape in Alabama

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ABSTRACT

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Two application schedules for chlorothalonil, a solution of sodium bicarbonate and horticultural oil, and an untreated control, were assessed for effectiveness in the control of blackspot of rose during 1992 and 1993 in Alabama using a variety of ground covers. Weekly applications of chlorothalonil were superior to applications following 0.63 cm of rain for both years. Sodium bicarbonate solution reduced disease when inoculum levels were low, i.e., after initial establishment of rose beds, but were ineffective in the subsequent year when inoculum levels were higher. In 1992, less blackspot developed on plants with oat straw or pine straw ground covers than on those with landscape mat or bare soil. In 1993, lowest disease severity was observed on plants with oat straw ground cover. When disease levels were high, severity of blackspot was inversely correlated to flower production on each of three varieties.

Additional keywords: *Diplocarpon rosae*, mulch, pesticide alternatives, fungicides

Roses are among the most popular flowering plants in the landscape. In the southeastern U.S., however, roses are often devastated by blackspot, caused by *Diplocarpon rosae* F. A. Wolf. Blackspot is characterized by roughly circular black lesions with fimbriate margins on leaves (5,10). Spots are frequently surrounded by a yellow halo, and infected leaves fall prematurely. When disease is severe, plants completely defoliate, resulting in a weakened plant (10) and reduced flower production.

Recommended control practices for blackspot on rose include sanitation and fungicide applications (10). Sanitation is two-fold, involving both regular removal of infected leaves and annual (early spring) replacement of mulch. Chemical control is possible if regular and frequent applications of protectant fungicides are made throughout the growing season. Several fungicides are labeled for control of blackspot (4); however, chlorothalonil has been shown to be superior to triforine, the only registered EBI-fungicide for use on roses (2,3).

Weekly fungicide applications are neither desirable nor convenient for homeowners. Besides the inconvenience, concerns have focused on safety and applicator exposure. Recently, Horst et al (6) found that weekly applications of a solution of sodium bicarbonate, in combination with a horticultural oil, controlled blackspot of rose in gardens in New York State. Due to Alabama's

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longer growing season, higher temperatures, and increased relative humidity, such treatments may not be as effective in this area.

Conidia of *D. rosae* are spread by rain splash or overhead watering, or are transmitted mechanically (5,10). Acervuli produce conidia from fallen leaves, and rain splash from the ground may spread spores. Thus, conditions that can minimize the momentum of raindrops, such as surface topography or "roughness" (11), could reduce blackspot spread and disease development.

This study was designed to evaluate the effectiveness of two application schedules of chlorothalonil and sodium bicarbonate solution, in combination with a variety of ground covers, on blackspot disease control on roses in Alabama. In addition, the effect of blackspot on vigor and flower production of plants was evaluated.

MATERIALS AND METHODS

Rose cultivars Cary Grant, Dolly Parton, and Princess Monaco were established at the Horticultural Subunit of the E. V. Smith Research Center, Alabama Experiment Station, near Shorter, Alabama. Roses were planted in exterior beds in February 1992. The study was arranged in a randomized complete block design with three replications. Plots consisted of one each of the three rose cultivars. Treatments were factorial arrangements of a fungicide treatment and ground cover. Fungicide treatments were *1)* nonsprayed control, *2)* chlorothalonil (Bravo 720 at 1.3 g a.i./L) applied to run-off on a weekly schedule, *3)* chlorothalonil (1.3 g a.i./L) applied after more than 63 mm of rain, and *4)* sodium bicarbonate solution (0.5% [w/v] = 5.3 g/L (baking soda, Arm & Hammer, Princeton, NJ) plus 1% horticultural oil (SunSpray Ultra-Fine Oil, Sun Company, Philadelphia, PA). Spray solutions were applied with a backpack sprayer, starting mid-May and continuing until 1 October. Sodium bicarbonate solution was applied twice per week in 1992 and once per week in 1993. Ground covers were *1)* bare soil, *2)* landscape mat, *3)* oat straw, *4)* pine straw, and *5)* pine bark. A 10-cm layer of each mulch was placed around the base of plants in March of each year. Despite recommendations (10), fallen leaves were not removed, and dormant sprays were not applied to the ground around the base of plants prior to replacement of mulch in the spring. Fertilizer was applied according to recommendations of the Alabama Cooperative Extension Service (10), and plants were drip-irrigated as needed. Insect and weed control was also implemented as needed. Rainfall and temperature data were measured by an electronic weather station maintained by National Weather Service staff and located near the main buildings of the Horticultural Unit.

Starting mid-May in 1992 and 1993, rose plants were assessed weekly through September for disease, flower production, and vigor. Suckers, spent flowers, and diseased canes were pruned weekly according to recommendations (10). Plant height (cm) was measured once per month. Visual ratings of disease were based on a scale of 0–5 where 0 = no disease, 1 = blackspot on approximately 1/5 of leaves with little or no defoliation, 2 = blackspot on 2/5 of leaves with minimal defoliation, 3 = blackspot on 3/5 of leaves with defoliation of plant, 4 = blackspot on most leaves with moderate defoliation, and 5 = all leaves with blackspot and severe defoliation of plant. Vigor was rated on a scale of 1–3 with 1 = poorly formed plant with little or no new growth and 3 = well-developed plant with abundant new growth.

Data collected on assessment dates on which height was measured (approximately monthly) were used for statistical analyses. Vigor and height were averaged over monthly data. Total flower production was calculated as the sum of monthly counts of buds, blooms, and spent flowers. Areas under the disease progress curves (AUDPC) were calculated for each treatment as: AUDPC = $[(1/2)(y_{i+1} + y_i)(t_{i+1} - t_i)$ where y = disease rating at time t and i = the day of the assessment from the first date of assessment (9). Treatment effects in each year were determined through analysis of variance (ANOVA) and means were compared using Fisher's protected least significant difference (LSD) (8). Significance was set at $P < 0.05$, unless otherwise stated. Weekly data, not used in statistical analyses, were compared with season-long data to check for consistency. Correlation coefficients were calculated between AUDPC and vigor, height, and flower production.

RESULTS

Weather conditions differed in the 2 yr of the study. Monthly temperatures from May through September averaged 23.8 C and 25.2 C for 1992 and 1993, respectively. Rain totaled 54.76 cm for May through September 1992, with greater than 0.63 cm rain falling during 17 autonomous 48-h periods. In 1993, total rain for May through September was 44.48 cm, with greater than 0.63 cm rain falling in 14 autonomous 48-h periods. Thus, rainfall greater than 0.63 cm triggered 17 and 14 applications of chlorothalonil in 1992 and 1993, respectively, compared with 20 applications of the weekly schedule for chlorothalonil.

In 1992, disease was not observed on plants until mid-August and AUDPC remained low. ANOVA indicated significant effects on AUDPC due to ground cover, spray treatment, and the interaction between ground cover and spray treatment. There was no effect on AUDPC due to variety. Roses treated weekly with chlorothalonil and oat straw ground cover had lowest AUDPC, while plants with no spray treatment and landscape mat had highest AUDPC (Fig. 1). The interaction effects of spray treatment with ground cover was generally reflected by single factor effects. AUDPC was significantly lower with weekly applications of chlorothalonil and significantly higher with no spray compared with applications of chlorothalonil after rain or sodium bicarbonate solution in 1992. Plants with pine and oat straw ground covers had significantly lower

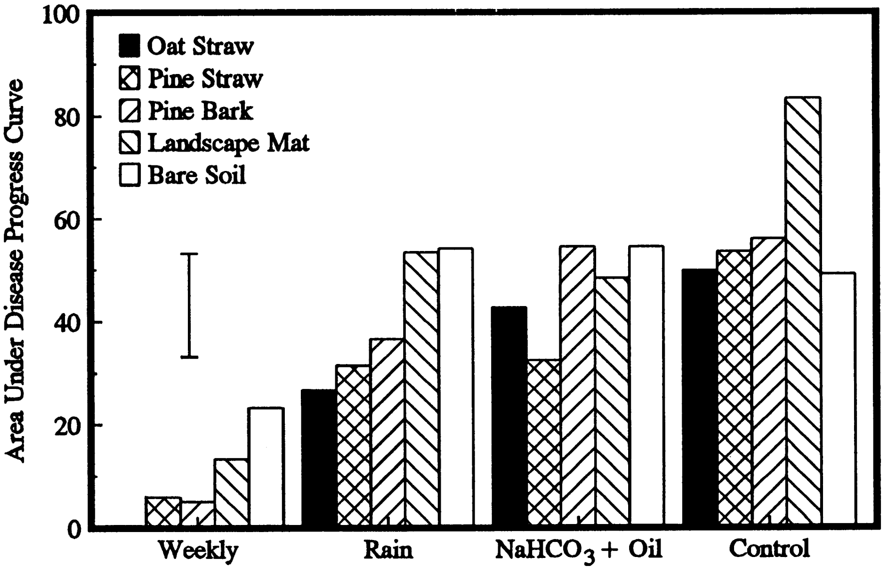

Fig. 1. Areas under disease progress curves of blackspot disease on rose due to spray treatments and ground covers in 1992. Chlorothalonil (1.3 g a.i./L) was applied either "weekly" or after 0.63 cm "rain." "$NaHCO_3$ + Oil" treatment consisted of 5.3 g/L $NaHCO_3$ plus 1% horticultural oil, applied twice per week. All treatments were applied to run-off. "Control" treatment was not sprayed. Line represents Fisher's protected least significant difference ($P < 0.05$) among all treatments.

AUDPCs than plants with landscape mat and in bare soil.

In 1993, AUDPC was significantly affected by spray treatment and variety. The two-way interaction between spray treatment and ground cover was the only significant interaction that affected AUDPC. Lowest AUDPC was observed on plants with oat straw ground cover that had been treated weekly with chlorothalonil (Fig. 2). Highest AUDPC was observed on sodium bicarbonate-treated roses in bare soil. When averaged over ground covers, blackspot on plants sprayed weekly with chlorothalonil was significantly lower than that on plants sprayed with chlorothalonil after rain; plants sprayed with either chlorothalonil schedule had significantly less blackspot than those treated with sodium bicarbonate or not sprayed. Averaged over the spray treatments, disease was significantly lower with oat straw as a ground cover than with bare soil. Princess Monaco had significantly lower disease than Dolly Parton, and Cary Grant was intermediate in disease reaction (Table 1).

In 1992, vigor, height, and total flower production were significantly affected by fungicide and variety but there were no interaction effects. Vigor, height, and flower production were each significantly lower for the sodium bicarbonate treatment than for other treatments (Table 2). Plants treated with chlorothalonil after rain had greater flower production than roses treated otherwise, although these plants had the same vigor and height as the unsprayed plants. Cary Grant was significantly taller, and Princess Monaco had significantly greater flower production, than other cultivars in 1992 (Table 1).

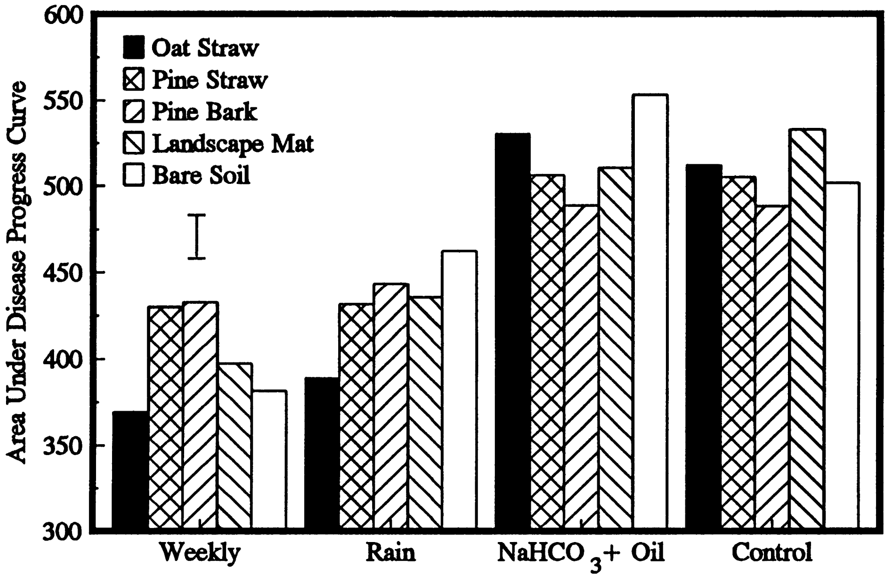

Fig. 2. Areas under disease progress curves of blackspot disease on rose due to spray treatments and ground covers in 1993. Chlorothalonil (1.3 g a.i./L) was applied either "weekly" or after 0.63 cm "rain". "$NaHCO_3$ + Oil" treatment consisted of 5.3 g/L $NaHCO_3$ plus 1% horticultural oil, applied weekly. All treatments were applied to run-off. "Control" treatment was not sprayed. Line represents Fisher's protected least significant difference ($P < 0.05$) among all treatments.

Table 1. Areas under disease progress curves for blackspot (AUDPC), and vigor, height, and flower production, averaged over five months (May through September) on three rose cultivars in Shorter, Alabama

Year and variety	AUDPC	Vigor[x]	Height (cm)	Flower production
1992				
Cary Grant	34.47[y]	2.40	74.40 a[z]	23.87 b
Dolly Parton	41.51	2.45	68.42 b	20.88 b
Princess Monaco	40.50	2.50	67.34 b	28.52 a
LSD	7.38	0.11	5.52	3.00
1993				
Cary Grant	463.04 ab	2.40 a	94.23 a	93.87 a
Dolly Parton	475.20 b	2.24 b	85.10 b	76.63 b
Princess Monaco	456.80 a	2.19 b	82.04 b	74.33 b
LSD	16.49	0.19	3.61	9.33

[x] Vigor was assessed on a scale from 1–3 where 1 = poorly developed plants and 3 = well-developed plants with new growth. Data are means over 5 months.
[y] Data are means from three varieties in three replications.
[z] Letters in columns, when different, indicate significant differences according to Fisher's protected least significant difference (LSD) ($P < 0.05$).

Weekly data reflected the results of season-long data for each study year.

In 1993, vigor and height were affected by spray treatment, ground cover, variety, and the two-way interaction between spray and ground cover. No other interactions had a significant effect on vigor or height. Generally, vigor and height were lowest with sodium bicarbonate plus oil treatment regardless of ground cover and greatest with weekly chlorothalonil applications except over bare soil (*data not shown*). Flower production was affected by fungicide and variety, but not by any factor interaction. When averaged over ground cover, plants treated with sodium bicarbonate solution had significantly lower vigor, height, and flower production than plants treated with either chlorothalonil treatment or not sprayed (Table 2). Flower production was similar for either chlorothalonil schedule, but vigor and height were significantly greater with weekly applications of the fungicide. In 1993, Cary Grant had significantly greater vigor, height, and flower production than other cultivars (Table 1). Analyses of season-long data were representative of trends in weekly data (*data not shown*).

Sodium bicarbonate plus oil treatments significantly reduced vigor of rose plants in both years of the study. Therefore, data from sodium bicarbonate plus oil treatments were omitted from analyses on flower production relative to disease. Over all 1992 data, there was a significant ($P < 0.01$) negative correlation between AUDPC and total flower production. Because of varietal differences in flowering, correlation coefficients were recalculated for each variety. Flower production was negatively correlated to AUDPC on Dolly Parton ($P < 0.10$) and on Cary Grant ($P < 0.01$) in 1992, although correlation coefficients were low ($r > -0.40$). Flower production, vigor, and height in 1993 were negatively correlated ($P < 0.10$, $P < 0.01$, and $P < 0.01$, respectively) to AUDPC. Each of the varieties in 1993 had a significant ($P < 0.01$) negative relationship between vigor and disease; Cary Grant and Dolly Parton had a significant ($P < 0.06$) negative relationship between disease and height. Flower production on Dolly Parton was inversely proportional ($P < 0.10$) to disease. Generally, however, correlation coefficients among disease, flower production, and vigor were low ($r > -0.40$).

DISCUSSION

Temperatures and humidities that prevail in the southeastern U.S. tend to be highly favorable to disease development on plants. Management practices or disease control options that provide moderate control in other areas may fail in this region of the country, but even partial effectiveness may be beneficial in

Table 2. Five month averages (May through September) for vigor, height, and flower production on rose plants treated for control of blackspot disease, in Shorter, Alabama

Year and treatment[w]	Frequency of application	Vigor[x]	Height (cm)	Flower production
1992				
Chlorothalonil	Weekly	2.47 b[y]	69.24 bc	25.20 b
Chlorothalonil	After rain[z]	2.60 a	76.56 a	28.84 a
Sodium bicarbonate solution	Twice per week	2.24 c	63.09 c	19.82 c
No treatment		2.50 ab	71.32 ab	23.82 b
LSD		0.16	6.37	3.63
1993				
Chlorothalonil	Weekly	2.55 a	97.33 a	100.49 a
Chlorothalonil	After rain	2.39 b	89.67 b	92.47 a
Sodium bicarbonate solution	Weekly	1.99 d	75.70 d	55.51 c
No treatment		2.18 c	85.39 c	77.98 b
LSD		0.10	4.17	10.78

[w] Chlorothalonil (1.3 g a.i./L) and sodium bicarbonate solution (5.3 g/L $NaHCO_3$ plus 1% horticultural oil) were applied to run-off.
[x] Vigor was assessed on a scale from 1–3 where 1 = poorly developed plants and 3 = well-developed plants with new growth.
[y] Letters within columns, when different, indicate significant differences according to Fisher's protected least significant difference (LSD) ($P < 0.05$).
[z] Fungicide applied to plants after 0.63 cm rain.

situations in which disease pressure is heavy. In this study, we demonstrated that sodium bicarbonate in solution with horticultural oil is less effective in the control of blackspot of rose in Alabama than was observed in previous work in gardens in New York (6).

In 1992, sodium bicarbonate plus oil solution reduced blackspot disease on roses compared with the untreated control. In 1993, however, blackspot on roses treated with the sodium bicarbonate plus oil solution was similar to the untreated control. Horst et al (6) postulated that bicarbonate is fungistatic in that conidial germination and penetration are inhibited. Thus, this treatment is likely to provide better control when inoculum levels are low. In the current study, inoculum levels were probably lower in the first year than the second year, allowing better treatment efficacy in 1992. We believe that inoculum levels were lower in 1992 because rose plants were newly established that year, disease was not observed until late in the season, and mild temperatures during the months of December through March (only 3 days had an average daily temperature < 0 C) (1) allowed greater inoculum survival from one year to the next.

Rose plants treated with sodium bicarbonate plus oil solution were significantly reduced in vigor and flower production in this study. Phytotoxity may result when horticultural oils are applied during prolonged periods of high temperatures. During the 2 yr of this study, the prevailing temperatures were apparently high enough to be detrimental to plants treated with the oil. These results are interesting because many homeowners and commercial plant growers in Alabama do not consider local summer temperatures to be excessively high.

Weekly applications of chlorothalonil gave the best disease control in this and other studies (2,3). Homeowners may not find this schedule either desirable or convenient. However, the occurrence of a "trigger" event to time fungicide applications may be compatible with home landscape maintenance. In this study, the occurrence of a significant rain event ($>$ 63 mm or 0.25 inches) was used as such a trigger for chlorothalonil applications, and rain-timed applications were effective in reducing disease compared with no fungicide applications. Chlorothalonil applications timed according to rainfall prevented severe disease levels that could reduce vigor and plant flowering. In addition, reduced frequency of chlorothalonil applications decreased visible fungicide residue on rose leaves, which is a common complaint when this fungicide is used.

This study also confirmed that ground cover can influence disease development. Yang et al (11) determined that the random roughness or surface topography of plastic, soil, and straw ground covers was highly correlated with propaguale dispersal. In studies with *Phytophthora cactorum* and *Colletotrichum acutatum* on strawberries, plastic ground cover allowed higher disease levels than straw ground cover (7,11). Similarly, blackspot was consistently lower on plants mulched with oat straw than on plants mulched with other ground covers in our study. While oat straw is not commonly used as a mulch in landscapes with roses, pine straw and pine bark are often used in Alabama. Of these two, pine straw has greater surface topography and blackspot development was suppressed with the use of pine straw compared with pine bark. Type of ground cover did not consistently affect plant vigor or flower production, although nutrient leachate may play a role in this system.

Control of blackspot on roses is optimal when sanitation is practiced. In this study, fallen leaves were not removed, and dormant sprays were not applied to the ground around the base of plants prior to replacement of mulch in the spring (10). Either of these practices could reduce initial inoculum such that sodium bicarbonate solution could have been more effective in established rose beds than it was observed to be in this study.

LITERATURE CITED

1. Anonymous. 1993. Weather summary for the state of Alabama, 1993. Ala. Agric. Exp. Stn., Agric. Weather Series No. 33.
2. Hagan, A. K., Gilliam, C. H., and Fare, D. C. 1988. Evaluation of new fungicides for the control of rose blackspot. J. Environ. Hortic. 6:67-69.
3. Hagan, A. K., Gilliam, C. H., Fare, D. C., and Bowen, K. 1991. Application rates and spray schedules of ergosterol-biosynthesis inhibitor fungicides for control of black spot of rose. Plant Dis. 75:1143-1146.
4. Hagan, A. K., and Mullen, J. M. 1988. Diseases of roses and their control. Ala. Coop. Ext. Serv. Circ. ANR-505.
5. Horst, R. K. 1990. Westcott's Plant Disease Handbook, 5th ed. Van Nostrand Reinhold, NY.
6. Horst, R. K., Kawamoto, S. O., and Porter, L. L. 1992. Effect of sodium bicarbonate and oils on the control of powdery mildew and black spot of roses. Plant Dis. 76:247-251.
7. Madden, L. V., and Ellis, M. A. 1990. Effect of ground cover on splash dispersal of *Phytophthora cactorum* from strawberry fruits. J. Phytopathol. 129:170-174.
8. SAS Institute. 1990. SAS/STAT User's Guide, Version 6, 4th Ed., Vol. 1. SAS Institute, Cary, NC.
9. Shaner, G., and Finney, R. E. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in Knox wheat. Phytopathology 67:1051-1056.
10. Shumack, R., Cobb, P., and Hagan, A. K. 1988. Growing Roses. Ala. Coop. Exten. Serv. Circ. ANR-157.
11. Yang, X., Madden, L. V., Wilson, L. L., and Ellis, M. A. 1990. Effects of surface topography and rain intensity on splash dispersal of *Colletotrichum acutatum*. Phytopathology 80:1115-1120.