Resistance of Shrub and Groundcover Roses to Black Spot and Cercospora Leaf Spot, and Impact of Fungicide Inputs on the Severity of both Diseases[1]

A.K. Hagan[2], M.E. Rivas-Davila[3], J.R. Akridge[4], and J.W. Olive[5]
Department of Entomology and Plant Pathology
Alabama Agricultural Experiment Station, Auburn University, AL

Abstract

Reaction of selected shrub and ground cover roses to black spot, Cercospora leaf spot, and powdery mildew, as well as the impact of fungicide inputs on the control of the above diseases, was assessed from 1999 through 2003 in a simulated landscape planting in Brewton, AL. Chlorothalonil at 1.25 g ai/liter was applied at 2- and 4-week intervals from mid-March until October to randomly selected plants in each replicate. An unsprayed control was also included in each replicate. Although black spot was the predominate disease observed, a number of rose selections suffered from objectionable Cercospora leaf spot-induced leaf spotting and premature defoliation. Few mixed outbreaks of black spot and Cercospora leaf spot on a single selection were seen. In all years, significant differences in the reaction of rose selections to black spot and Cercospora leaf spot were noted. Of the roses damaged by black spot, the least leaf spot and defoliation were noted on the unsprayed Ice Meidiland®, Mystic Meidiland®, Red Cascade™, 'Hansa', 'Pink Grootendorst', 'Pink Pet', and to a lesser extent Carefree Wonder™ and Pearl Sevillana™. In a residential planting, monthly applications of chlorothalonil or other recommended fungicide would be needed to protect the above rose selections from a destructive black spot outbreak. 'Betty Prior', Bonica®, Cherry Meidiland®, First Light™, Kent™, Jeepers Creeper™, Livin' Easy™, Lilian Austin™, 'Nearly Wild', 'Nozomi', Butterfly rose, Ralph's Creeper™, Raven™, Royal Bonica™, 'Sea Foam', Sevillana™, and Sweet Chariot™ were susceptible to black spot. While black spot did not appreciably damage Carefree Delight™, Flower Carpet®, White Flower Carpet®, Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', Polar Ice™, *R. wichurana*, The Fairy™, and 'Therese Bugnet', considerable Cercospora leaf spot development occurred on all of the above rose selections. Of these roses, Polar Ice™, Fuchsia Meidiland®, and Fire Meidiland® exhibited the highest resistance to Cercospora leaf spot and may not require any fungicide inputs to maintain plant health and vigor. Magic Carpet™ and Knock Out™ roses, which were susceptible and resistant to black spot, respectively, as well as Flower Carpet®, and White Flower Carpet® appeared to be poorly adapted to the hot and sometimes dry summer weather patterns of South Alabama. In nearly all years, chlorothalonil gave better control of both diseases when applied on a 2-week than on a 4-week schedule. Significant chlorothalonil-induced leaf burn was seen on First Light™, Flower Carpet®, 'Hansa', Happy Trails™, Magic Carpet™, Mystic Meidiland™, 'Nozomi', and Raven™. Consistent powdery mildew development was found only on 'Therese Bugnet' and to a lesser extent on Red Cascade™ and 'Petite Pink Scotch'. Canopy spread of the roses that were heavily damaged by black spot and Cercospora leaf spot often was often reduced in size when compared with that of adjacent chlorothalonil-treated plants of the same selection. In contrast, little if any increase in growth was obtained with fungicide inputs for the more disease resistant rose selections.

Index words: disease resistance, disease control, *Diplocarpon rosae*, *Spharotheca pannosa* var. *rosae*, *Cercospora rosicola*, floribunda rose, Daconil Ultrex, chlorothalonil, phytotoxicity, leaf burn.

Species used in this study: hybrid *Rosa* sp., *R. wichurana*, *R. chinensis*, *R. damescena.*

Significance to the Nursery Industry

Historically, black spot is considered the most common and damaging disease on a wide variety of rose selections in the hot and humid Coastal South. However, Cercospora leaf spot, which has never been recognized as a destructive disease of rose, caused extensive leaf spotting and premature defoliation on a surprising number of rose selections. In contrast, the development of powdery mildew at this location in southwest Alabama was limited to only three roses. Shrub and ground cover roses with resistance to black spot and Cercospora leaf spot were identified. Ice Meidiland®, Mystic Meidiland®, Red Cascade™, 'Pink Pet', 'Hansa' and 'Pink Grootendorst' suffered from less leaf spotting and premature defoliation than the remaining black spot-susceptible roses. All of the above roses probably can be maintained in a residential landscape with no more than monthly applications of a recommended fungicide. Those selections that suffered the least Cercospora leaf spot damage and could be maintained with minimal fungicide protection were Polar Ice™, Fuchsia Meidiland®, and Fire Meidiland®. While neither black spot nor Cercospora leaf spot heavily damaged Knock Out™, a noticeable lack of plant vigor and flowering appeared to be related to a combination of high temperature stress and/or chlorothalonil phytotoxicity. Other heat-sensitive roses included Magic Carpet™, Flower Carpet®, and White Flower Carpet®. Chlorothalonil-induced leaf injury was also seen on First Light™, Flower Carpet®, 'Hansa', Happy Trails™, Magic Carpet™, Mystic Meidiland™, 'Nozomi', and Raven™. When compared with the untreated controls, the growth indices were usually higher for the fungicide-protected plants of most of the susceptible and a few of the partially disease resistant rose selections.

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[2]Professor, Department of Entomology and Plant Pathology; e-mail: haganak@auburn.edu.

[3]Former Research Associate, Department of Entomology and Plant Pathology.

[4]Superintendent, Brewton Agricultural Experiment Unit, Brewton, AL.

[5]Superintendent, Ornamental Horticulture Research Unit, Mobile, AL.

Introduction

Across much of the United States, black spot, which is caused by the fungus *Diplocarpon rosae* F.A. Wolf

(teleomorph: *Marssonina rosae* (Lib.) Died), is the most widespread and destructive disease of rose (*Rosa* sp.) (11, 30). In Alabama and adjacent states, temperature and rainfall patterns from April to early November are conducive to the development of black spot (28). On susceptible roses, leaf spotting and premature defoliation due to black spot often begin shortly after leaf emergence, and disease development continues until the first hard frost. In addition to poor plant aesthetics, black spot-induced premature defoliation has been correlated with reduced flowering, as well as suppressed the growth of some hybrid tea rose cultivars (3).

Of the other diseases reported on roses nationwide, powdery mildew is often considered second in importance only to black spot (28). The distinctive white myclial mat of the causal fungus *Sphaerotheca pannosa* var. *rosae* (Wallr: Fr.) Woronichin on the leaves, flower buds, shoots, and thorns, as well as yellowing and distortion of the unfurling leaves are characteristic of a severe powdery mildew outbreak on rose (11, 28). On the basis of observations made during previous Alabama (3, 5, 7, 8) and North Carolina (1) field trials on hybrid tea and grandiflora roses, the risk of significant powdery mildew damage is negligible here compared to that attributed to black spot.

Leaf spotting and premature defoliation on rose may also be attributed to Cercospora leaf spot, which is caused by the fungus *Cercospora rosicola* Pass. (teleomorph: *Mycosphaerella rosicola* B. H. Davis) (30). While the lack of information on Cercospora leaf spot suggests that this disease is considered to be of little importance (11), damaging outbreaks of this disease, particularly on shrub roses have recently been noted in Alabama (5) and North Carolina (1). Previously, Cercospora leaf spot was reported on greenhouse roses in California (12) and hybrid tea roses in South Africa (2).

Shrub roses (*Rosa* sp.) are a loosely defined group of unrelated heirloom, garden, florabunda, and modern hybrid roses that are considered hardier, more vigorous, and versatile but equally colorful as hybrid tea and grandiflora roses. Depending on the cultivar chosen, their growth habit ranges from erect bushy to a sprawling low-growing ground cover form with multiple simple, semi-double, or double blossoms on each stem. While good or excellent disease resistance is claimed in the patent documentation and sales literature for many of Meidiland® roses that were included in this study, specific references to resistance to black spot or other rose diseases are not made (14, 15, 16, 17, 18, 19, 20, 22). However, resistance to black spot and powdery mildew is listed in patent documents for Mystic Meidiland® (23) and Ice Meidiland® (24) and to black spot alone for Cherry Meidiland® (21). In the patent documentation for Knock Out™ (29), resistance to black spot and rust is noted, while Kent™ is described as having excellent resistance to black spot, powdery mildew, downy mildew and rust (27). Black spot, powdery mildew, and rust resistance are claimed for White Flower Carpet® (26) and First Light™ (13), while Flower Carpet® (25) reportedly is resistant to black spot.

Dirr (6) noted that Scarlet Meidiland® and White Meidiland® suffered the least black spot-related leaf spotting and premature defoliation of selected rose cultivars in the Meidiland® series in the landscape in Athens, GA. Clendenen *et al.* (5) noted in a rose planting near Montgomery, AL, that Red Meidiland® was sensitive to Cercospora leaf spot but was relatively free of black spot. At Fletcher, NC, in the Appalachian Mountains, black spot and Cercospora leaf spot were noted on Alba Meidiland®, Scarlet Meidiland®, and Pink Meidiland® (1). By the end of the growing season, Pink Meidiland® and Linda Campbell™ were almost completely defoliated by the combination of black spot and Cercospora leaf spot (1). Bir *et al.* (1) also noted that *R. rugosa* rose selections, 'Blanc Double de Coubert', 'Fru Dagmar Hastrup', 'Rugosa alba', and 'Topaz Jewel' were largely free of diseases. Spencer and Wood (31) reported significant differences in the response of selected roses in the Alba, Bourbon, Cenifolia, China, Damask, Gallica, Hybrid Perpetual, Moss, and Portland (Old Garden Roses) classes to *D. rosae*. More recently, 'The Fairy', Belinda's Dream™, Flower Carpet®, and 'Le Vesuve' were reported to have partial resistance to black spot, which could be controlled with bi-monthly applications of chlorothalonil (5). In Louisiana, the shrub roses Livin' Easy™ and Carefree Delight™, when treated weekly with a fungicide, suffered far less black spot damage than a sizable number of hybrid tea, grandiflora, and floribunda roses (10). Hagan and Olive (9) noted that container-grown Magic Carpet™, Jeepers Creeper™, and Red Ribbons™ were much more susceptible to black spot than Ralph's Creeper™.

The objectives of this study were to determine the susceptibility of Meidiland®, as well as other selected shrub and ground cover roses, to black spot and powdery mildew in a simulated landscape planting and to assess the impact of fungicide inputs on disease severity and plant growth. In addition, other diseases that have a detrimental impact on the health and beauty of shrub roses were identified and cultivar reaction to diseases along with fungicide inputs was defined.

Materials and Methods

In 1998, a simulated landscape planting of selected Meidiland®, as well as other ground cover and shrub roses was established at the Brewton Agricultural Experiment Field, Brewton, AL, (USDA Plant Hardiness Zone 8a) to assess their susceptibility to black spot, powdery mildew, and other diseases, as well as their overall adaptability to the humid, warm, and often wet climate of the Coastal South. Typically, bare-root roses were potted into 3.8 liter containers in a pine bark:peat (3:1 by vol) substrate amended with 4.9 kg of 17N–3.1P–10.0K Osmocote (17–7–12), 2.1 kg of dolomitic limestone, 0.7 kg of gypsum, and 0.5 kg of Micromax per cubic meter at the Ornamental Horticulture Research Center in Mobile, AL.

Prior to the initial planting, soil fertility and pH of a Benndale (A) fine sandy loam were adjusted according to the results of a soil fertility assay conducted by the Auburn University Soil Testing Laboratory. On January 30 and March 19, 1998, roses were transplanted into raised beds at the Brewton Agricultural Research Unit. Subsequently, some bare-root rose selections were directly transplanted into the field plots. Additional rose selections, which are listed in the following paragraph, were added in 1999, 2000, 2001, and 2002. Beds were then mulched with 2.5 to 5 cm (1–2 in) of aged pine bark. A drip irrigation system with a single emitter per plant was installed at the time of establishment and the plants were watered as needed. Up to five applications of approximately 85 g of 16N–1.8P–6.7K (16–4–8), which was distributed uniformly around each plant, were made at 6- to 8-week intervals during the growing season. Directed applications of 0.68 kg ai/ha of Gallery DF™ and 2.2 kg ai/ha of Surflan T/O™ to the mulched beds were made in late winter

and in late spring to control annual weeds. Hand weeding and spot applications of recommended rates of the herbicide 912 Herbicide 6S™ (monosodium methanearsonate [MSMA]) were used to control yellow nutsedge, other escaped weeds, and encroaching centipedegrass. In January or February of each year, scaffold canes on each bush were cut back to approximately 30 to 40 cm above the soil surface. Fresh mulch was also added in late winter.

On January 30, 1998, 'Betty Prior', Bonica® (*R*osa sp. 'Meidomonac'), Fushia Meidiland® (*R.* sp. 'Meipelta'), Carefree Delight™ (*R.* sp. 'Meipotal'), First Light™ (*R.* sp. 'Devrudi'), Livin Easy™ (*R.* sp. 'Harwelcome'), Mystic Meidiland® (*R.* sp. 'Meialate'), 'Nearly Wild', Pearl Sevillana™ (*R.* sp. 'Meichonar'), Sevillana™ (*R.* sp. 'Meigekanu'), Cherry Meidiland® (*R.* sp. 'Meirumour'), Red Cascade™ (*R.* sp. 'Moorcap'), 'Petite Pink Scotch', 'Nozomi', Royal Bonica® (*R.* sp. 'Meimodac'), 'Sea Foam', *R. wichurana*. Flower Carpet® (*R.* sp. 'Noatraum'), Magic Carpet™ (*R.* sp. 'Jaclover'), Ralph's Creeper™ (*R.* sp. 'Morpapplay), Happy Trails™ (*R.* sp. 'Jaccasp'), Jeeper's Creeper™ (*R.* sp. 'Korissel), 'The Fairy', and White Flower Carpet® (*R.* sp. 'Noaschnee') were transplanted on March 19, 1998. Butterfly rose (*R. chinensis* 'Mutabulis') was planted on June 4, 1998, and Double Delight™ (*R.* sp. 'Andeli'), Carefree Wonder™ (*R.* sp. 'Meipitac'), 'Hansa', and 'Pink Grootendorst' were established on February 11, 1999. In 2000, Kent™ (*R.* sp. 'Poulcov'), Knock Out™ (*R.* sp. 'Radazz'), Fire Meidiland® (*R.* sp. 'Meipsidue'), Ice Meidiland® (*R.* sp. 'Meivahyn'), 'Therese Bugnet', Raven™ (*R.* sp. Frytrooper), and Sweet Chariot™ (*R.* sp. Morchari) were substituted for 'Nearly Wild', 'Betty Prior', Royal Bonica®, Magic Carpet™, Bonica®, and Double Delight™. Polar Ice™ (*R.* sp. 'Stronin'), *R. damescena* 'Madame Hardy', and Lilian Austin™ (*R.* sp. 'Ausmond'), which were added to this study on February 26, 2001, replaced Livin Easy™, Sevillana™, and White Flower Carpet®. Ralph's Creeper™ was replaced with 'Pink Pet' (syn. 'Caldwell Pink') on November 11, 2002.

The study consisted of a split plot with five replications of rose selections as the main plot and fungicide treatment as the split-plot. The contact fungicide chlorothalonil [Daconil Weather Stik® 6F, Syngenta Professional Products, Greensboro, NC] was applied at 2-or 4-week intervals at 1.25 g ai/liter of spray volume. One plant in each plot was left untreated. Fungicides were applied to run-off at the above intervals with a hand wand using a tractor-mounted sprayer from March 22 to November 12, 1999, April 5 until October 19, 2000, March 22 until October 17, 2001, March 15 to October 9, 2002, and March 20 to September 25, 2003.

Severity of black spot was visually evaluated in all five years at 6- to 8-week intervals. Simultaneously, plants were examined for the characteristic symptoms and signs of powdery mildew, downy mildew, and Cercospora leaf spot. Leaf samples were collected periodically to confirm the identification of black spot or Cercospora leaf spot on certain rose selections. A modified Florida peanut leaf spot rating scale, where 1 = no disease, 2 = very few spots in lower canopy, 3 = light spotting lower and upper canopy, 4 = some spots in lower and upper canopy with light defoliation (≤10%), 5 = spots noticeable with moderate defoliation (≤25%), 6 = spots numerous with significant defoliation (≤50%), 7 = spots numerous with severe defoliation (≤75%), 8 = most remaining leaves spotted with excessive defoliation (≤90%), 9 = very few remaining leaves covered with spots, and 10 = plants defoliated, was used to assess the severity of black spot and Cercospora leaf spot (4). In 1999, severity ratings for black spot and Cercospora leaf spot were recorded on March 23, May 6, June 24, August 30, October 7, and November 11. For 2000, ratings for black spot and Cercospora leaf spot were logged on April 12, May 23, June 27, September 11, September 29, and November 10. Black spot and Cercospora leaf spot severity was recorded on April 4, May 16, June 15, August 9, September 7, and November 2, 2001; April 25, May 29, August 12, October 2, and November 6, 2002; and April 17, May 28, July 26, September 13, and October 8, 2003. Disease ratings recorded on September 29, 2000, September 7, 2001, October 2, 2002, and October 8, 2003 are presented. Plant dimensions were recorded on October 6, 2003. The growth index (GI) was calculated using the following formula: GI = (height + width 1 + width 2) / 3. Significance of rose cultivar selection and fungicide treatment interval effects were tested by analysis of variance. Means for each fungicide treatment on individual rose selections were compared with Fisher's protected least significance difference (LSD) test with a level of significance at $P = 0.05$. Due to highly significant differences ($P = 0.0001$) among rose selections for black spot and Cercospora leaf spot severity, fungicide treatment interval and rose selection × treatment interval interaction; data for rose selections and fungicide treatment intervals were not pooled (data not shown).

Results and Discussion

As expected, black spot was the most common and damaging disease observed over the evaluation period. Noticeable leaf spotting and premature leaf shed due to Cercospora leaf spot was also seen on a surprising number of shrub and ground cover roses. Typically, only one of these two diseases developed on a given rose selection during the study period. With the exception of one rose selection, the incidence of powdery mildew was low. Despite extended periods of heavy spring rains in several years, downy mildew never developed on any cultivar.

Black spot. In March and early April, newly unfurled leaves were free of symptoms of black spot. On the most black spot-susceptible roses, significant lesion formation and leaf chlorosis that appeared in early to mid-May was quickly followed in mid- to late June by noticeable premature defoliation (data not shown). Lesion formation and premature defoliation intensified through the summer until peaking in September or October. In contrast, noticeable leaf spotting and premature defoliation on the more black spot-resistant selections was usually delayed until August or September.

In all years, significant differences in the severity of black spot were noted among shrub and ground cover roses that were not treated with chlorothalonil (Table 1). In addition, this disease was found on approximately 70% of the rose selections screened. Black spot did damage Carefree Delight™, Flower Carpet®, White Flower Carpet®, Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', Polar Ice™, *R. wichurana*, The Fairy™, and 'Therese Bugnet' (data not shown). Claims of black spot resistance that previously were made for Flower Carpet® (25), White Flower Carpet® (26), and The Fairy™ (13) were confirmed. All of the above rose selections, however, were damaged by Cercospora leaf spot (Table 2).

Table 1. Effect of fungicide inputs on the severity of black spot on selected cultivars of shrub and ground cover roses at the Brewton Agricultural Research Unit.

	Black spot severity[z]														
	1999 Application interval[y]			2000 Application interval			2001 Application interval			2002 Application interval			2003 Application interval		
Cultivar	UTC[x]	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk
Butterfly rose	6.2	5.8	4.8	5.6	3.4	2.0	6.6	5.4	3.4	6.0	5.2	3.6	5.4	4.6	3.4
Carefree Wonder™	6.5	6.6	6.0	5.6	5.3	4.3	5.8	5.0	4.0	5.0	5.3	4.3	4.6	4.3	3.0
Cherry Meidiland®	7.2	7.0	5.2	7.3	5.0	3.4	7.3	6.5	3.4	6.3	5.8	4.5	6.0	4.5	2.8
First Light™	6.2	6.0	4.2	6.5	5.0	3.6	6.8	6.0	3.5	7.0	5.3	4.8	6.3	4.8	3.6
'Hansa'	4.8	4.2	3.8	5.4	4.6	4.2	5.5	4.8	3.8	5.8	5.0	4.8	5.8	4.4	4.4
Ice Meidiland®	—[w]	—	—	3.0	2.0	1.6	4.0	3.2	2.0	4.8	3.2	2.6	4.0	3.0	1.4
Jeeper's Creeper™	7.2	6.8	6.2	7.0	5.6	4.2	7.4	5.6	3.8	7.8	6.8	5.8	7.2	6.2	5.0
Kent™	—	—	—	6.8	5.4	3.2	6.2	5.8	3.2	6.2	6	4	5.2	5.2	2.2
Lillian Austin™	—	—	—	—	—	—	6.5	5.3	4.0	6.8	6.5	5.0	6.2	6.8	5.4
Livin' Easy™	5.4	5.8	5.4	7.0	7.2	5.0	—	—	—	—	—	—	—	—	—
'Madam Hardy'	—	—	—	—	—	—	5.8	2.8	2.2	5.8	4.0	2.6	5.8	3.4	1.8
Mystic Meidiland®	5.0	4.8	3.2	4.2	3.2	2.0	4.0	4.0	3.0	5.5	4.8	3.8	4.8	3.4	3.0
'Nozomi'	5.6	5.6	4.0	6.0	5.4	4.6	6.6	6.0	5.8	6.8	5.8	5.4	6.6	5.4	5.4
Pearl Sevillana™	5.6	5.6	5.0	5.6	4.2	2 4	7.2	6.6	4.8	6.6	5.6	4.0	7.0	5.8	3.8
'Pink Grootendorst'	5.0	4.4	2.4	5.6	4.0	2.6	6.0	5.2	4.0	6.2	5.0	3.8	5.4	4.6	2.6
Ralph's Creeper™	6.6	6.0	3.4	6.6	5.3	4.0	7.8	6.5	4.6	6.0	5.8	5.2	—	—	—
Raven™	—	—	—	7.0	6.0	3.6	7.0	6.6	4.8	7.0	6.6	5.4	6.8	5.6	4.6
Red Cascade™	3.4	2.4	1.6	3.6	2.4	1.5	5.8	4.0	2.6	5.0	4.0	2.0	4.8	3.6	2.0
'Sea Foam'	5.6	5.6	4.0	6.0	4.2	2.8	7.0	4.2	3.2	6.8	4.0	2.4	5.8	2.6	1.8
Sevillana™	6.8	6.2	5.6	7.0	5.6	3.6	—	—	—	—	—	—	—	—	—
Sweet Chariot™	—	—	—	6.8	4.8	3.2	6.4	4.4	2.2	6.8	6.2	4.6	5.8	5.2	3.8
LSD (P = 0.05)[v]			0.9			1.0			1.1			0.9			0.6

[z]Black spot severity was recorded on October 7, 1999, September 29, 2000, September 7, 2001, October 2, 2002, and September 13, 2003, on a 1 to 10 scale.

[y]Chlorothalonil (Daconil Weather Stik) was applied at two- and four-week intervals.

[x]UTC = Untreated controls, which were not sprayed with chlorothalonil.

[w]— = No data, cultivar not yet installed or removed.

[v]Mean separation for disease severity data in each year was according to Fisher's protected least significant difference test (P = 0.05).

Table 2. Effect of fungicide treatments on the severity of Cercospora leaf spot on selected cultivars of shrub and ground cover roses at the Brewton Agricultural Research Unit.

	Cercospora leaf spot severity[z]														
	1999 Application interval[y]			2000 Application interval			2001 Application interval			2002 Application interval			2003 Application interval		
Cultivar	UTC[x]	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk	UTC	4 wk	2 wk
Carefree Delight™	7.0	6.5	5.2	7.0	6.0	3.2	7.6	5.4	3.2	7.0	5.8	4.0	7.0	5.8	3.4
Flower Carpet®	5.8	6.0	5.8	6.0	5.4	6.0	5.0	2.2	2.8	6.8	5.5	5.8	4.7	4.0	3.5
Fire Meidiland®	—[w]	—	—	5.2	3.4	3.2	4.0	2.4	1.6	5.8	4.8	3.4	4.4	2.4	1.6
Fuchsia Meidiland®	5.6	5.0	3.3	4.8	3.2	2.4	3.8	2.4	2.0	5.0	4.2	3.0	4.0	2.6	2.2
Happy Trails™	5.5	5.0	3.0	5.8	4.0	2.8	6.0	3.6	3.0	6.6	4.4	3.6	6.6	3.8	3.0
'Petite Pink Scotch'	5.6	4.8	4.0	4.8	2.4	1.6	5.6	4.0	2.8	6.2	3.8	2.0	6.0	4.0	2.0
Polar Ice™ [v]	—	—	—	—	—	—	3.6	2.6	1.8	4.8	3.2	2.6	4.6	3.6	2.0
R. wichurana	3.0	1.3	1.3	3.4	1.8	1.8	1.8	1.0	1.2	3.4	1.4	1.8	2.6	1.6	1.4
'Therese Bugnet'	—	—	—	5.2	5.8	3.8	6.0	6.4	5.4	6.8	6.8	6.2	6.2	6.4	5.2
The Fairy™	6.4	5.8	4.2	6.2	5.4	3.2	6.0	4.0	2.6	6.6	5.0	4.0	5.8	4.0	2.2
White Flower Carpet®	7.0	6.0	5.4	6.3	6.0	4.2	—	—	—	—	—	—	—	—	—
LSD (*P* = 0.05)[u]			0.5			0.7			0.8			0.7			0.6

[z]Cercospora leaf spot severity was assessed on October 7, 1999, September 29, 2000, September 7, 2001, October 2, 2002, and September 13, 2003, on a 1 to 10 scale.

[y]Chlorothalonil (Daconil Weather Stik) was applied at 2- and 4-week intervals.

[x]UTC = Untreated controls, which were not sprayed with chlorothalonil.

[w]— = No data, plants not yet installed or removed.

[v]Polar Ice™ was added to study in 2001.

[u]Mean separation for disease severity data in each year was according to Fisher's protected least significant difference test (P = 0.05).

Untreated Ice Meidiland®, Mystic Meidiland®, and Red Cascade™ as well as 'Hansa' often had significantly lower black spot ratings than those of many of the remaining rose selections (Table 1). Black spot ratings for Ice Meidiland® were significantly below those obtained for Red Cascade™ in 2001 and 2003, Mystic Meidiland® in 2000, 2001, and 2003, and 'Hansa' over a four-year period. The level of leaf spotting and premature defoliation recorded for Red Cascade™ was significantly lower compared with the symptom severity noted on Mystic Meidiland® and 'Hansa' in two and three years, respectively. Beginning in 2001, black spot ratings for Carefree Wonder™ and 'Madam Hardy', respectively, were not significantly different than those for Red Cascade™, Mystic Meidiland®, and 'Hansa'. In 2002 and 2003, disease ratings for Carefree Wonder™ were also similar to those recorded for Ice Meidiland®. In three of five years, black spot severity on 'Pink Grootendorst' also did not significantly differ from the damage level found on the other rugosa rose 'Hansa', as well as on several of the above rose selections. In contrast, Ice Meidiland® consistently suffered significantly less black spot-induced leaf spotting and premature leaf loss than 'Pink Grootendorst'. While Pearl Sevillana™ had black spot severity ratings that were comparable to those for 'Pink Grootendorst' in 1999 and 2000, this cultivar had significantly higher levels of defoliation in 2001, 2002, and 2003. In 2003, disease ratings for 'Pink Pet', which suffered less than 25% defoliation, were comparable to those recorded in the same year for Ice Meidiland® and Mystic Meidiland® (data not shown).

When left untreated with the chlorothalonil fungicide, Cherry Meidiland®, First Light™, Kent™, Jeepers Creeper™, Livin' Easy™, Lilian Austin™, 'Nozomi', Butterfly rose, Ralph's Creeper™, Raven™, 'Sea Foam', Sevillana™, and Sweet Chariot™ suffered from severe leaf spotting and premature leaf loss (Table 2). Other roses that were highly susceptible to black spot were 'Betty Prior', Bonica®, 'Nearly Wild', and Royal Bonica® (data not shown). However, Butterfly rose often had a lower black spot severity rating than many of the above rose selections. Defoliation levels on this unique rose ranged between approximately 35% in 2000 to nearly 65% in the following year. Roses that were most susceptible to black spot were Jeeper's Creeper™, Ralph's Creeper™, Raven™, Cherry Meidiland®, Bonica®, and 'Betty Prior'. By the end of the summer, black spot severity ratings were 7.0 or above, with defoliation levels that consistently reached or exceeded the 75% level with very few lesion-free leaves.

As previously noted by Meilland (24), Ice Meidiland® is resistant to black spot. Of the 21 rose cultivars susceptible to black spot, this rose selection had among the lowest damage ratings. With a black spot rating no higher than the 4.8 recorded after the unusually wet summer of 2002, defoliation level for untreated Ice Meidiland® was below 25%. In 2001 and 2003, black spot-induced defoliation on this rose selection did not exceed 10%. In the drought year of 2000, no black spot-induced defoliation was observed on Ice Meidiland®. While Red Cascade™ had higher black spot ratings in two of four years than Ice Meidiland®, this rose also demonstrated partial resistance to this disease. Results of this study agree with Meilland (23) that Mystic Meidiland® is also partially resistant to black spot. As indicated by a disease rating of 4.0 to 5.0 in most years, defoliation on untreated Mystic Meidiland® ranged from10 to 25%. Reduced levels of leaf spotting and defoliation were also noted on 'Hansa', 'Pink Grootendorst', and Carefree Wonder™. In contrast to available information, Cherry Meidiland® (21), First Light™ (13), and Kent™ (27) proved highly susceptible to black spot. Ralph's Creeper™, which previously showed good resistance to black spot (9), suffered from 50 to more than 75% premature leaf shed, as well as heavy spotting of the remaining leaves. As was noted in this study, Hagan and Olive (9) reported that Jeeper's Creeper™ was highly susceptible to black spot. In addition, heavy and objectionable levels of black spot-induced defoliation were also noted on Livin' Easy™, Lilian Austin™, 'Nearly Wild', 'Nozomi', Butterfly rose, Raven™, 'Sea Foam', Sevilliana™, and Sweet Chariot™. A similar level of heavy defoliation was also noted on 'Betty Prior', Bonica®, and Royal Bonica™ (data not shown).

Cercospora leaf spot. Development of Cercospora leaf spot on susceptible rose selections closely paralleled that observed for black spot. Symptoms of Cercospora leaf spot were found on all of the rose selections that were not damaged by black spot. Considerable differences in leaf spotting and premature defoliation due to Cercospora leaf spot were noted on Carefree Delight™, Flower Carpet®, Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', Polar Ice™, *R. wichurana*, The Fairy™, 'Therese Bugnet' and White Flower Carpet® that were not treated with chlorothalonil (Table 2). In contrast, Cercospora leaf spot was not observed on Cherry Meidiland®, First Light™, Kent™, Jeepers Creeper™, Livin' Easy™, Lilian Austin™, 'Nozomi', Butterfly rose, Ralph's Creeper™, Raven™, Royal Bonica™, 'Sea Foam', Sevillana™, and Sweet Chariot™ as well as Meidiland®, Mystic Meidiland®, Red Cascade™, 'Hansa', 'Pink Grootendorst', Carefree Wonder™, and Pearl Sevillana™. Also, this disease was note observed on 'Betty Prior', Bonica®, 'Nearly Wild', 'Pink Pet', or Royal Bonica® (data not shown).

The least Cercospora leaf spot damage was observed on the creeping ground cover *Rosa wichurana*. By late summer to early fall, symptoms on this rose were limited in four of five years to light to moderate spotting on the leaves and light premature defoliation around the base of the plant (Table 2). Lesion development was concentrated in the area around the base of *R. wichurana* but was rarely seen on the leaves along the runners. In 2001, Cercospora leaf spot development on this cultivar was restricted to light spotting in the lower canopy without any defoliation.

Of the remaining roses damaged by Cercospora leaf spot, significant spotting of the leaves and premature defoliation was noted. Of these, untreated Polar Ice™, Fuchsia Meidiland®, and Fire Meidiland®, which suffered from 10 to 40% premature defoliation over a three-, four-, or five-year period, respectively, were among the selections least susceptible to Cercospora leaf spot (Table 3). Defoliation levels, which ranged from 25 to 50% for Happy Trails™ and Flower Carpet®, were often slightly higher for 'Petite Pink Scotch' and The Fairy™. Carefree Delight™, which suffered 70 to 80% premature leaf loss and heavy spotting of all remaining leaves, proved to be the most susceptible of all of the rose selections to Cercospora leaf spot. In 2002 and 2003, 'Therese Bugnet' lost all but a few leaves at the shoot tips to Cercospora leaf spot.

Cercospora leaf spot was more widespread and damaging than expected. Outbreaks of this disease were noted on ap-

proximately 30% of the roses screened from 1998 through 2003. Symptom severity on susceptible roses was comparable to the level of premature defoliation on roses heavily damaged by black spot. Cercospora leaf spot is a particular cause for concern on some Meidiland® roses (1, 5). In addition to Fire Meidiland® and Fuchsia Meidiland®, Alba Meidiland®, Scarlet Meidiland®, and Pink Meidiland® in North Carolina (1), as well as Red Meidiland® in Alabama (5) are susceptible to Cercospora leaf spot. Anecdotal information concerning the susceptibility of Flower Carpet® and White Flower Carpet® to this disease is confirmed. Other roses that proved to be unacceptably sensitive to Cercospora leaf spot were Happy Trails™, 'Petite Pink Scotch', The Fairy™, Carefree Delight™, and 'Therese Bugnet'.

Powdery mildew. Development of powdery mildew was limited to a few rose selections. In 1999 and 2000, the characteristic white mycelial mats of *S. pannosa* were not found on the leaves or flower buds of any rose selections (data not shown). Heavy powdery mildew development was seen in late spring 2001, 2002, and 2003 on the leaves of 'Therese Bugnet' and to a lesser extent on Red Cascade™ (data not shown). During the same time period in 2002 and 2003, noticeable colonization by *S. pannosa* on the flower buds of 'Petite Pink Scotch' was also noted. First Light™ (13), Mystic Meidiland® (22), Ice Meidiland® (24), Flower Carpet® (25), White Flower Carpet® (26), and Kent™ (27), which were previously described as resistant to powdery mildew, were not colonized by *S. pannosa*.

Table 3. Impact of fungicide inputs on the growth of selected shrub roses, Brewton Agricultural Research Unit, 2003[z].

	Growth Index (GI)[y]			
	Application interval			
Cultivar	2 wk	4 wk	UTC[x]	LSD[w]
Butterfly rose	171	153	111	15.1
Carefree Delight™	154	137	113	17.3
Carefree Wonder™	98	88	62	21.1
Cherry Meidiland®	85	71	48	30.8
First Light™	83	76	66	16.6
Flower Carpet®	78	86	82	ns
Fire Meidiland®	110	103	100	ns
Fuchsia Meidiland®	139	136	119	ns
Happy Trails™	103	103	77	ns
'Hansa'	160	159	140	ns
Ice Meidiland®	130	117	117	ns
Jeepers Creeper™	143	122	89	27.9
Kent™	108	107	91	ns
Knock Out™	80	89	93	ns
Lilian Austin™	73	67	44	19.9
'Madame Hardy'	93	81	68	22.5
Mystic Meidiland®	103	120	114	ns
'Nozomi'	99	92	82	9.8
Pearl Sevillana™	90	80	57	13.9
'Petite Pink Scotch'	159	149	123	16.4
'Pink Grootendorst'	150	148	138	ns
'Pink Pet'	77	75	63	12.8
Polar Ice™	125	139	119	ns
Raven™	115	93	57	29.1
Red Cascade™	141	140	124	ns
Rosa wichurana	103	97	95	ns
'Sea Foam'	126	124	123	ns
Sweet Chariot™	98	91	75	11.6
The Fairy™	119	125	103	6.5
'Therese Bugnet'	148	135	134	10.9

[z]Height and widths for all rose selections were recorded on October 6, 2003.

[y]Growth Index (GI) was calculated using the following formula: (height + width 1 + width 2) / 3 = GI.

[x]UTC = Untreated controls, which were not sprayed with chlorothalonil.

[w]Mean separation was according to Fisher's protected least significant difference test (P = 0.05).

Fungicide inputs and the severity of black spot and Cercospora leaf spot. Regardless of cultivar sensitivity to black spot or Cercospora leaf spot, substantial reductions in the severity of both diseases on most rose selections were obtained with chlorothalonil. Typically, black spot or Cercospora leaf spot ratings for roses treated at two-week intervals were lower than those for the same cultivar maintained on a monthly treatment schedule. Monthly chlorothalonil applications also reduced the severity of both of the above diseases compared with the unsprayed plants of the same rose selection.

On the partially black spot resistant Red Cascade™ and Ice Meidiland®, symptoms on the plants treated at two-week intervals with chlorothalonil were limited in all years to light spotting in the lower canopy with no premature defoliation (Table 1). When treated at four-week intervals, leaf spotting in the lower and upper canopy, as well as unobtrusive defoliation (≤10%), on both of these rose selections was significantly below the level that was seen on the untreated plants but was significantly higher than symptom severity on these same selections treated at two-week intervals. In 2001, 2002, and 2003, the level of leaf spotting and premature defoliation noted on Mystic Meidiland®, 'Madame Hardy', and 'Sea Foam' treated on a two- and four-week schedule was similar to the severity of black spot on observed on Red Cascade™ and Ice Meidiland® maintained on the same spray schedules. Defoliation levels on these same rose selections, when treated monthly, typically did not exceed 10%. In addition, disease severity on untreated Mystic Meidiland®, 'Madame Hardy', and particularly the black spot susceptible 'Sea Foam' was significantly higher compared with those obtained for these same rose selections treated monthly with chlorothalonil. Reductions in black spot severity similar to those noted on the above cultivars treated at two-week intervals were also recorded in three of five years for 'Pink Grootendorst' and two of four years for Sweet Chariot™. However, the level of defoliation recorded in the remaining one or two years for the above rose selections ranged between10 and 25%. When maintained on a monthly fungicide treatment schedule, 'Pink Grootendorst' and Sweet Chariot™ had significantly higher disease ratings compared to Mystic Meidiland®, 'Madame Hardy', Red Cascade™ and Ice Meidiland®. In one and two years, disease ratings for the untreated 'Pink Grootendorst' and Sweet Chariot™, respectively, were similar to those of these same rose selections maintained on a monthly treatment schedule.

While extensive premature leaf loss was noted on the Butterfly rose, Carefree Wonder®, Cherry Meidiland®, First Light™, Kent™, and Sevillana™ treated monthly or when left untreated, moderate leaf spotting and relatively light defoliation was seen on these same rose selections treated at two-week intervals with chlorothalonil (Table 1). Surprisingly, bimonthly and monthly chlorothalonil treatments failed to prevent light to moderate defoliation on 'Hansa' and Knock Out™. Several rose selections such as Jeepers Creeper®, Lilian Austin™, Livin' Easy™, 'Nozomi', Ralph's Creeper™,

and Raven™ proved so susceptible to black spot that the bi-monthly chlorothalonil applications failed to appreciably slow disease spread. As indicated by disease ratings of 5.0 or above, a minimum of 25% defoliation was seen on Jeepers Creeper™, Lilian Austin™, Livin' Easy™, 'Nozomi', Ralph's Creeper™, and Raven™ that were maintained on the two-week chlorothalonil program. When the application interval was extended from two- to four-weeks, defoliation levels for the above rose selections increased to the 50 to 75% level. Disease severity for Jeepers Creeper®, Lilian Austin™, Livin' Easy™, 'Nozomi', Ralph's Creeper™, and Raven™ treated monthly with chlorothalonil and the untreated controls of these roses often did not significantly differ.

When compared with the untreated controls, severity of Cercospora leaf spot was consistently reduced on nearly all rose selections with chlorothalonil applied at two- and four-week intervals. For the highly Cercospora leaf spot-resistant *R. wichurana*, symptoms on the chlorothalonil-treated plants were limited to single leaf spots on a handful of leaves (Table 2). For the remaining roses, disease ratings were usually lower for the plants treated at two-week intervals compared with those receiving monthly applications of chlorothalonil. For Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', and Polar Ice™ damage on the plants treated on a two-week schedule was usually restricted to light leaf spotting in the lower and sometimes upper leaf canopy. While some light defoliation was found on the above roses treated monthly, the level of premature defoliation did not negatively impact their appearance or floral display. When treated on a two-week schedule, The Fairy™, Carefree Delight™, and White Flower Carpet® suffered considerably less leaf spotting and defoliation due to Cercospora leaf spot than did these same selections receiving monthly fungicide treatments. 'Therese Bugnet' proved so susceptible to Cercospora leaf spot that chlorothalonil applied at two-week intervals failed to prevent 25 to 50% premature leaf loss as well as considerable spotting of the remaining leaves. Response of Flower Carpet® to fungicide inputs was very erratic. In two of four years, noticeable reductions in the severity of Cercospora leaf spot were obtained with both the two- and four-week chlorothalonil programs. As was the case on the other rose selections, disease ratings for the plants treated at two-week intervals were lower than for those treated with chlorothalonil on a monthly schedule. On Flower Carpet® in 2000 and 2002, both of the chlorothalonil programs gave relatively little control of Cercospora leaf spot.

Knock Out™ did not appear to have been seriously damaged by either black spot or Cercospora leaf spot. While little lesion development was seen on the leaves of this rose selection, the dense leaf canopy seen on nearly all of the other rose selections, particularly the plants treated on a two-week schedule with chlorothalonil, never developed. Since antidotal reports indicate that Knock Out™ is resistant to black spot and Cercospora leaf spot, perhaps the thin canopy of this rose selection was due to fungicide phytotoxicity or sensitivity to high daytime temperatures during June, July, and August.

Impact of disease and fungicide inputs on the growth of shrub roses. Moderate to heavy leaf spotting and premature defoliation associated with severe outbreaks of black spot and Cercospora leaf spot often had a significant impact on the growth of many of rose selections. Canopy spread of untreated black spot- and Cercospora leaf spot-susceptible roses was often much smaller than that of the adjacent fungicide-treated plants of the same rose selection. In contrast, fewer differences in canopy height or spread could be seen between the unsprayed controls and the fungicide-treated plants of the cultivars that demonstrated partial resistance to either disease. Overall, black spot and Cercospora leaf spot appeared to have a similar impact on the growth of cultivars, particularly on those that were highly susceptible to either disease.

The growth index [GI] of the unsprayed controls of the black spot or Cercospora-susceptible Butterfly rose, Carefree Delight™, Carefree Wonder™, Cherry Meidiland®, Jeepers Creeper™, Lilian Austin™, Pearl Sevillana™, 'Petite Pink Scotch', Raven™, Sweet Chariot™, 'The Fairy' were reduced by 20 to 40% compared to the plants treated monthly with chlorothalonil (Table 3). Sizable differences in the GI for Butterfly rose, Carefree Delight™, Cherry Meidiland®, Jeeper's Creeper™, Raven™, and 'Therese Bugnet' were also noted between the plants treated at two- and four-week intervals with chlorothalonil. On several of the black spot and Cercospora leaf spot-susceptible cultivars, particularly 'Therese Bugnet', sizable increases in overall plant dimensions were noted despite heavy early fall leaf spotting and premature defoliation on the chlorothalonil-treated roses. Previously, Bowen *et al.* (3) noted that severe outbreaks of black spot resulted in significant reductions in the growth and floral display of hybrid tea roses.

On cultivars with partial resistance to black spot or Cercospora leaf spot such as Fire Meidiland®, Fuchsia Meidiland®, 'Hansa', Ice Meidiland®, Mystic Meidiland®, 'Pink Grootendorst', 'Pink Pet', Polar Ice™, Red Cascade™, and *Rosa wichurana*, a reduction of approximately 10% in plant size was seen between the roses treated monthly with chlorothalonil and the unsprayed controls of the same cultivar (Table 3). In most cases, the GI for the above roses differed by 10% or less for the two- and four-week chlorothalonil programs. For Flower Carpet® and 'Sea Foam', which suffered considerable damage from Cercospora leaf spot and black spot, respectively, no differences in plant size were noted between the two fungicide programs and the unsprayed plants. Similar results to those obtained for 'Sea Foam' were also observed for 'Nozomi' and Knock Out™.

Cultivar sensitivity to chlorothalonil and heat stress. The potential for formulations of chlorothalonil to scald, burn, or otherwise damage the leaves of roses is well known among rosarians. Typical symptoms associated with chlorothalonil-induced phytotoxicity, which were most noticeable on the roses treated with this fungicide on a two-week schedule, included bronzing or chlorosis of the leaves, noticeable irregular 'burnt' or brown spots on the upper leaf surfaces, and premature leaf shed. The most extensive leaf burn and premature leaf shed was observed on the hybrid tea rose Double Delight™ in 1999. The premature leaf shed and sparse canopy seen in 2003 on Knock Out™ may also be related to chlorothalonil-induced phytotoxicity. Other rose selections that were periodically damaged by applications of chlorothalonil were First Light™, Flower Carpet®, 'Hansa', Happy Trails™, Magic Carpet™, Mystic Meidiland®, 'Nozomi', and Raven™.

Sensitivity to high temperatures, which was characterized by yellowing or chlorosis of the leaves, as well as premature

leaf loss and shoot dieback, was observed particularly during extended periods of hot summer weather in 2000 and 2001. Magic Carpet™ and White Flower Carpet® proved especially sensitive to high temperature injury. On Magic Carpet™ and to a lesser extent on White Flower Carpet®, leaf roll, premature leaf shed, dieback of the lateral shoots, and finally plant death were observed shortly after the initial yellowing of the leaves. Considerable heat-related leaf yellowing was also noted in 2003 on Cherry Meidiland®.

While black spot was observed on more rose selections, Cercospora leaf spot was more widespread and damaging on shrub and ground cover rose selections than anticipated. While few references to Cercospora leaf spot are found in the literature, significant disease-related damage was recently reported in Central Alabama on several shrub rose selections (5). Previously, rose pathology research has largely been focused on black spot and little if any effort has been made to assess the importance of or to develop control strategies for Cercospora leaf spot. While Clendenen *et al.* (5) noted that Cercospora leaf spot caused relatively minor damage, the level of leaf spotting and premature defoliation attributed to Cercospora leaf spot that was seen here was quite similar to the damage seen on black spot-susceptible rose selections. In addition, reductions in plant growth similar to those previously noted on black spot-damaged roses by Bowen *et al.* (3) were also noted for those selections that suffered significant leaf spotting and premature defoliation.

Considerable differences in susceptibility to black spot were noted among the rose selections. Some roses proved nearly immune to black spot, while other suffered heavy spotting of the leaves and premature defoliation. Few if any symptoms of black spot were seen on Carefree Delight™, Flower Carpet®, White Flower Carpet®, Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', Polar Ice™, *R. wichurana*, 'The Fairy', and 'Therese Bugnet' but all were damaged to some extent by Cercospora leaf spot. Buildup of black spot on the shrub rose selections Ice Meidiland®, Mystic Meidiland®, Red Cascade™, and 'Pink Pet' as well as the rugosa roses 'Hansa' and 'Pink Grootendorst' was much slower than the pace of disease development on most of the remaining rose selections. Since the season-end defoliation levels for all of the above roses, when left untreated, ranged from nearly 25 to 50%, monthly fungicide treatments would be required in the Coastal South and probably in the remainder of Alabama to main optimum plant health. In regions of the United States where black spot is less damaging, fungicide inputs may not be needed to maintain the beauty and vigor of these roses in the landscape.

'Betty Prior', Bonica®, Cherry Meidiland®, First Light™, Kent™, Jeepers Creeper™, Livin' Easy™, 'Madame Hardy', 'Nearly Wild', 'Nozomi', Butterfly rose, Ralph's Creeper™, Raven™, Royal Bonica®, 'Sea Foam', Sevillana™, and Sweet Chariot™ were highly susceptible to black spot. Of these, Jeepers Creeper™, Lilian Austin™, 'Nozomi', and Ralph's Creeper™ proved so sensitive to this disease that weekly fungicide treatments would be required to maintain healthy and vigorous selections of these rose selections in Alabama landscapes.

While little if any black spot was found on Carefree Delight™, Flower Carpet®, White Flower Carpet®, Fire Meidiland®, Fuchsia Meidiland®, Happy Trails™, 'Petite Pink Scotch', Polar Ice™, *R. wichurana*, 'The Fairy', and 'Therese Bugnet', all of these roses suffered from moderate to heavy Cercospora leaf spot related-leaf spotting and sometimes from considerable premature defoliation. Of these, the most attractive and least Cercospora leaf spot-susceptible selections were Polar Ice™, Fuchsia Meidiland®, and Fire Meidiland®. Along the Gulf Coast or other locations where heavy Cercospora leaf spot damage is high, monthly applications of chlorothalonil or another efficacious fungicide during the summer should control this disease on the above rose selections. In North Alabama and points further north, fungicide inputs may not be required to maintain healthy and vigorous landscape plantings of Polar Ice™, Fuchsia Meidiland®, and Fire Meidiland®, as well as 'Petite Pink Scotch' and Happy Trails™ roses. Flower Carpet® and White Flower Carpet® roses, which were not only susceptible to Cercospora leaf spot but also intolerant to the summer heat and humidity of the Coastal South, may be poor choices for USDA Zone 8. In contrast, Cercospora leaf spot was not found on Flower Carpet® in an earlier study conducted near Montgomery, AL (5). In a cooler and drier climate where Cercospora leaf spot may be less of a threat, both of these roses also may have relatively few disease problems and may be more attractive. 'Therese Bugnet' proved susceptible to Cercospora leaf spot and powdery mildew but also failed to flower and was invasive. Although *R. wichurana* has the best overall disease resistance package of all the rose selections, sparse flower buds and an extremely invasive growth habit make this rose a poor choice except for right-of-way or other non-landscape uses.

Noticeable symptoms of Cercospora leaf spot were not found on 'Betty Prior', Bonica®, Cherry Meidiland®, First Light™, Kent®, Jeepers Creeper™, Lilian Austin™, Livin' Easy™, 'Madame Hardy', 'Nearly Wild', 'Nozomi', Butterfly rose, Ralph's Creeper™, Raven™, Royal Bonica®, 'Sea Foam', Sevillana™, and Sweet Chariot™, as well as Ice Meidiland®, Mystic Meidiland®, Red Cascade™, 'Pink Pet', 'Hansa', and 'Pink Grootendorst'.

As previously reported by Bowen *et al.* (3), rose growth may be slowed by severe black spot-related leaf spotting and premature defoliation. In this study, similar reductions in plant growth were also linked to damaging outbreaks of Cercospora leaf spot. With both diseases, reductions in growth were greater for the more susceptible rose selections than for those with partial resistance to either black spot or Cercospora leaf spot. Plant growth, especially that of the black spot- or Cercospora leaf spot-susceptible cultivars, was greatly enhanced by fungicide inputs. Typically, the GI for the black spot- and Cercospora leaf spot-susceptible rose selections was higher for the plants treated with a fungicide on a two- than on a four-week schedule. For many of the disease-resistant roses, the GI for plants sprayed on a two-and four-week schedule with chlorothalonil often were not appreciably different. Bowen *et al.* (3) also noted that the number of flowers on several hybrid tea cultivars declined as the severity of black spot increased.

Fungicide treatments not only failed to appreciably increase leaf retention but also damaged the leaves on Knock Out™ and Double Delight™. Leaf loss on Knock Out™ appeared to be related more to chlorothalonil phytotoxicity and/or heat-related stress than to black spot. Chlorothalonil-sensitive cultivars also included First Light™, Flower Carpet®, 'Hansa', Happy Trails™, Magic Carpet™, Mystic Meidiland, 'Nozomi', and Raven™.

Historically, black spot, and to a lesser extent other diseases have often heavily damaged roses in landscapes across

Alabama. Intensive fungicide programs, which are often required to control black spot and maintain plant health, have discouraged the installation of roses in residential and commercial landscapes. The disease-resistant shrub and ground roses, such as those described in this report, have the potential to greatly broaden the market for these colorful, versatile, and sometimes fragrant plants across Alabama.

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