



This Journal of Environmental Horticulture article is reproduced with the consent of the Horticultural Research Institute (HRI – www.hriresearch.org), which was established in 1962 as the research and development affiliate of the American Nursery & Landscape Association (ANLA – <http://www.anla.org>).

HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

The use of any trade name in this article does not imply an endorsement of the equipment, product or process named, nor any criticism of any similar products that are not mentioned.

Resistance of Selected Cultivars of Indian Hawthorn to Entomosporium Leaf Spot, Fireblight, and Anthracnose in Alabama¹

A. K. Hagan², J. R. Akridge³, K. L. Bowen², J. W. Olive⁴, and K. M. Tilt⁵

Department of Entomology and Plant Pathology
Alabama Agricultural Experiment Station, Auburn University, AL 36849-5624

Abstract

Resistance of 19 cultivars of Indian hawthorn (*R. umbellata* and *R. x delacourii*) to the diseases Entomosporium leaf spot (*Entomosporium mespili*), fireblight (*Erwinia amylovora*), and anthracnose (*Colletotrichum gloeosporioides*) was evaluated in a simulated landscape planting in Brewton, AL. Although symptoms of Entomosporium leaf spot were observed each year on the foliage of all cultivars, significant differences in disease severity were noted. Over the four-year test period, the lowest level of leaf spotting and premature leaf shed was consistently seen on Indian Princess® and Olivia™. Significant differences in the susceptibility of Indian hawthorn cultivars to fireblight, particularly in 1997 and 1998, were also noted. 'Janice' and 'Jack Evans', which proved particularly susceptible to this disease, resulted in the death on nearly all plants. In those same years, minor fireblight damage was also seen on Olivia™. Noticeable anthracnose-induced leaf damage and premature defoliation was recorded in 1997 only on Majestic Beauty®. Among the cultivars of Indian hawthorn screened, Indian Princess® suffered the least damage due to Entomosporium leaf spot, fireblight, and anthracnose over the four-year trial period. Olivia™ has excellent resistance to Entomosporium leaf spot but may prove sensitive to fireblight.

Index words: *Rhaphiolepis umbellata*, *Rhaphiolepis x delacourii*, Yeddo hawthorn, disease resistance, *Erwinia amylovora*, *Entomosporium mespili*, *Colletotrichum gloeosporioides*.

Species used in this study: Indian hawthorn (*R. umbellata* (Thunb.) Mak., *R. x delacourii* Andre).

Significance to the Nursery Industry

While Entomosporium leaf spot is widely recognized as a common and damaging disease in the nursery and landscape on Indian hawthorn, the potential impact of fireblight on the production and maintenance of this evergreen shrub has not previously been recognized. Anthracnose significantly damaged only the upright cultivar Majestic Beauty® (*R. x 'Montic'*) and was not a threat to dwarf-type Indian hawthorns. Cultivars of Indian hawthorn resistant to Entomosporium leaf spot and fireblight were identified. Overall, the dwarf-type cultivar Indian Princess® (*R. umbellata* 'Monto'), and to a lesser extent Olivia™ (*R. umbellata* 'Conia'), Eleanor Tabor™ (*R. umbellata* 'Conor'), Gulf Green™ (*R. umbellata* 'Minor'), demonstrated the best overall resistance to all diseases. The majority of the remaining cultivars were highly susceptible to either Entomosporium leaf spot or to fireblight.

Introduction

Indian hawthorn (*R. umbellata* (Thunb.) Mak., and *R. x delacourii* Andre), with its dark-green evergreen foliage, mounded canopy, and typically compact growth habit, has long been a fixture in residential and commercial landscapes across the southeast (2). While the majority of cultivars of Indian hawthorn are dwarf-type plants, a few such as Rosalinda® and Majestic Beauty® are large shrubs with an open canopy and upright growth habit. In both the nursery

and landscape, Entomosporium leaf spot, which is caused by the fungus *Entomosporium mespili* (DC.) Sacc., is widely recognized as the most common and damaging disease of Indian hawthorn (1, 8, 10). Typically, spotting of the leaves begins in Alabama in late fall to early winter. On highly susceptible cultivars, leaf spotting and defoliation, which starts at the base of the plant, continues through early spring until all but the youngest leaves at the shoot tips have been shed (4). In south Alabama, disease spread on Indian hawthorn has been especially rapid following several days of mild, cloudy, and wet winter weather. Unlike photinia, little if any spread of Entomosporium leaf spot occurs during the summer and early fall on Indian hawthorn (Hagan, personal observation).

Cultivars of Indian hawthorn and related *Rhaphiolepis* taxa are known to differ in their susceptibility to Entomosporium leaf spot (5, 6, 7, 9). Corely (1) reported that Majestic Beauty®, 'Snow White', 'Pink Lady' and *R. x delacourii* Andre had high levels of disease resistance. However, 'Jack Evans', Springtime® (*R. umbellata* 'Monme'), 'Fascination' and Enchantress® (*R. umbellata* 'Moness') suffered heavy leaf spot-related damage (1). In recent studies in Georgia (9) and Louisiana (5), several newly released cultivars of Indian hawthorn such as Olivia™ also demonstrated good resistance to Entomosporium leaf spot. Tilt *et al.* (12) noted that cultivars of Indian hawthorn with good leaf spot resistance also had superior aesthetic ratings.

Entomosporium leaf spot is not the only damaging disease that occurs on Indian hawthorn. In Alabama, outbreaks of fireblight, a bacterial disease caused by *Erwinia amylovora* (Burrill) Winslow *et al.*, has occasionally been seen on Indian hawthorn in landscape plantings and on container stock in nurseries. Due to the extensive blossom blight and shoot dieback, fireblight-damaged Indian hawthorns are unmarketable. Holcomb (6) recently reported that a field planting of Olivia™ succumbed to this disease, while the remaining cul-

¹Received for publication on August 17, 2000; in revised form on January 11, 2001.

²Professor, Department of Entomology and Plant Pathology.

³Superintendent, Brewton Experiment Field.

⁴Superintendent, Ornamental Horticulture Substation.

⁵Professor, Department of Horticulture.

tivars of Indian hawthorn were not damaged. Overall, the susceptibility of the most commercially available Indian hawthorn cultivars to fireblight is unknown.

The fungus, *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz., which causes a leaf spot, leaf blight and dieback disease called anthracnose, is a common pathogen on a wide range of annual, perennial, and woody landscape plants (11). While several taxa of *Rhaphiolepis* are reported as hosts of *C. gloeosporioides* (3), little information is available concerning the occurrence of anthracnose in landscape plantings or the sensitivity of specific cultivars to this potentially destructive plant pathogenic fungus.

The objective of this study was to determine the susceptibility Indian hawthorn (*R. umbellata*, and hybrid *R. x delacourii*) of members of the two taxa of *Rhaphiolepis* to Entomosporium leaf spot, fireblight and anthracnose in a simulated landscape planting. Also, the identification and severity any other diseases that might threaten the health and aesthetics of Indian hawthorn was assessed.

Material and Methods

Before planting, soil fertility and pH of a Benndale (A) fine sandy loam soil were adjusted according to the results of a soil fertility assay done by the Auburn University Soil Testing Laboratory. In March 1994, the initial planting of dwarf cultivars of Indian hawthorn and the upright selection Majestic Beauty® was established on 5-foot centers spaced 6 feet apart on the Brewton Experiment Field in Brewton, AL (USDA Plant Hardiness Zone 8a), which is located approximately 50 miles northeast of Pensacola, FL. In March 1995, the 'Snow White' and Rosalinda® (*R. umbellata* 'Conda'), which are dwarf and upright forms, respectively, were added. The dwarf Indian hawthorn Bay Breeze® (*R. umbellata* 'Hines Darkleaf') was planted in March 1996. The majority of Indian hawthorn cultivars were transplanted from #1 (2.8 liter) containers.

The experimental design was a randomized complete block with 6 three-plant replications. A drip irrigation system was installed immediately after planting and plants were watered as needed. Beds were mulched as needed with 2.5 to 5 cm (1 to 2 in) of aged pine bark. Twice each spring, approximately 85 g (3 oz) of a 16N-4P₂O₅-8K₂O fertilizer was uniformly distributed around each plant. Directed applications of 0.68 kg a.i./ha (1 lb/A) of Gallery™ DF and 2.2 kg a.i./ha (2 qt/A) of Surflan™ T/O were made early each spring down the row center to control annual weeds. Hand weeding and spot applications of recommended rates of the herbicides Roundup™ or 912 Herbicide 6S (monosodium acid methanearsonate [MSMA]) was used to control escape weeds and invading centipedegrass. The centipedegrass alleys between the rows were mowed periodically.

Within the first year, Entomosporium leaf spot was well established on the susceptible cultivars of Indian hawthorn. Beginning in 1995, visual ratings of Entomosporium leaf spot were periodically made on a scale of 1 to 5 where 1 = no disease, 2 = 1 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, and 5 = 76 to 100% of leaves diseased or prematurely shed. Entomosporium leaf spot ratings reported in this paper were taken on May 24, 1995; May 29, 1996; May 19, 1997, and May 13, 1998. On June 29, 1997 and August 5, 1998, fireblight severity was assessed on a scale of 0 to 4 where 0 = no disease, 1 = one or a few blighted shoot tips, 2 = numerous shoot tips blighted and a few scaffold branches killed, 3

= major portion of the shrub killed, 4 = plant dead. Anthracnose damage was assessed on June 29, 1997 and August 5, 1998 using the scale previously described for Entomosporium leaf spot. Significance of cultivar by year and disease effects was tested by analysis of variance and means were compared with Fisher's protected least significance difference (LSD) test with a level of significance at $P = 0.05$.

Results and Discussion

Entomosporium leaf spot. Entomosporium leaf spot, which was the most common disease observed, was noted on all 19 cultivars of Indian hawthorn. However, sizable differences in the level of disease-related spotting of the foliage and leaf shed were seen among those cultivars evaluated from 1995 through 1998 (Table 1). Over the four-year test period, Olivia™ and Indian Princess™ suffered the least leaf spotting and premature leaf shed (Table 1). In each year, damage on Olivia™ was restricted to light spotting of the leaves around the base of the plant and no premature leaf shed was noted. Although Indian Princess® was largely free of Entomosporium leaf spot in the first three years of this trial, noticeable spotting of the leaves appeared in 1998. In 1995, light and unobtrusive leaf spotting was noted on *R. x delacourii*. However, the entire stand of this cultivar died simultaneously in the fall 1995 shortly after two hurricanes drenched the Brewton test site.

In the first three years of this study, Entomosporium leaf spot severity on Gulf Green™, 'Janice', and Eleanor Tabor™

Table 1. Severity of Entomosporium leaf spot on selections and taxa of Indian hawthorn at the Brewton Experiment Field, 1995 to 1998.

Selection	Disease severity ratings ^a			
	1995	1996	1997	1998
Gulf Green™	1.0 ^y	1.0	2.8	3.5
Indian Princess®	1.1	1.1	2.3	2.7
Olivia™	1.1	1.1	2.0	2.2
<i>R. x delacourii</i> ^x	1.4	—	—	—
'Snow White' ^w	1.6	1.7	3.2	3.3
'Janice'	1.9	1.9	2.6	—
Majestic Beauty®	2.0	2.0	3.0	3.5
Eleanor Tabor™	2.2	2.2	2.5	3.3
'Jack Evans'	2.2	2.2	3.0	—
'Clara'	2.3	2.3	4.0	3.5
Rosalinda® ^w	2.5	2.5	3.0	3.3
Bay Breeze® ^y	—	—	3.6	4.8
Spring Rapture®	3.2	3.2	4.0	4.5
Enchantress®	3.3	3.3	4.5	4.3
'Heather'	3.5	3.5	4.0	4.8
'Pinkie'	3.5	3.5	4.2	4.5
Harbinger of Spring®	3.6	3.6	4.6	4.4
White Enchantress®	3.6	3.6	4.6	4.0
Springtime®	3.9	3.9	4.7	4.0
LSD ($P = 0.05$)	0.5	0.3	0.6	0.6

^aEntomosporium leaf spot severity was assessed on a scale of 1 to 5 where 1 = no disease, 2 = 1 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, and 5 = 76 to 100% of leaves diseased or defoliated.

^yMean separation within columns was according to Fisher's protected least significance (LSD) test ($P = 0.05$).

^xAll *R. x delacourii* died by the early winter of 1996.

^wRosalinda and Snow White were planted in March 1995.

^yBay Breeze was established in March 1996 but disease ratings were not taken until the following year.

was generally similar to that seen on Olivia™ and Indian Princess® (Table 1). However, the level of leaf spotting and premature leaf shed seen in 1998 was significantly higher on Gulf Green™ and Eleanor Tabor™ as compared with Olivia™ and Indian Princess®. Since the entire stand of ‘Janice’ succumbed in 1998 to fireblight, no Entomosporium leaf spot ratings were collected that year. Other cultivars which suffered from light leaf spotting as well as a low level of premature leaf shed in 1995 and 1996 included ‘Clara’, ‘Jack Evans’, and Majestic Beauty®. In 1996, low levels of Entomosporium leaf spot were also noted on ‘Snow White’ and to a lesser extent on Rosalinda®. In 1997 and 1998, the severity of Entomosporium leaf spot intensified on ‘Clara’, Majestic Beauty®, ‘Snow White’, Rosalinda® Indian hawthorn to the point that objectionable spotting of the leaves and leaf shed were seen. Overall, leaf spot damage was heavier in 1997 and 1998 than in the previous two years.

Indian hawthorn selections most susceptible to Entomosporium leaf spot were Bay Breeze®, Spring Rapture® (*R. umbellata* ‘Monrey’), Springtime®, White Enchantress® (*R. umbellata* ‘Monant’), ‘Heather’, Enchantress®, Harbinger of Spring®, and ‘Pinkie’. Although the disease severity ratings for these cultivars in one or more years did significantly differ, all of the above cultivars usually suffered from heavy spotting of the foliage and premature leaf shed (Table 1). As indicated by disease ratings of 4.0 or above, the majority of these Indian hawthorn cultivars were almost completely defoliated by the May 1997 and 1998 rating dates. Despite such severe damage over a two- to four-year period, none of the cultivars screened died as a result of Entomosporium leaf spot (data not shown). Corley (1) also noted that Springtime® and Enchantress® were highly susceptible to Entomosporium leaf spot. Due to the intensive and costly fungicide spray programs required to maintain plant health and aesthetics, the production and establishment of the above cultivars in Alabama and in other states where Entomosporium leaf spot is prevalent should be avoided.

Although a number of the cultivars of Indian hawthorn were moderately to highly susceptible to Entomosporium leaf

spot, Olivia™ and Indian Princess® consistently demonstrated a high level of resistance to this disease over the four-year test period. With the notable exception of 1998, the disease severity ratings for Eleanor Tabor™ and Gulf Green™ usually did not differ significantly from those recorded for Olivia™ and Indian Princess®. Recently, Holcomb (5) and Ruter (9) have also rated Olivia™ as being among the most leaf spot-resistant cultivars of Indian hawthorn. As previously noted (1, 4), *R. x delacourii* demonstrated good disease resistance but did not survive through the 1995-growing season. In a recent Louisiana study (5), damage on Eleanor Tabor™ was limited to light spotting of the leaves but heavy leaf spot damage was seen on this cultivar in a 1999 Georgia study (9), the same year that serious damage was noted in our current study. Over the test period, disease intensity gradually increased on Majestic Beauty®, ‘Clara’, ‘Jack Evans’, ‘Snow White’, Rosalinda® and Bay Breeze® to the point that the damage was objectionable. Ruter (9) reported much heavier leaf spot damage on ‘Snow White’ and ‘Clara’ than was noted in this study. In contrast, Corley (1) reported that ‘Jack Evans’ was highly susceptible to Entomosporium leaf spot while Majestic Beauty® and ‘Snow White’ suffered only light leaf spotting.

Fireblight. In 1997, characteristic fireblight symptoms such as blossom blight and shoot dieback first appeared on selected cultivars of Indian hawthorn between the April 20 and May 19 rating dates. As indicated by fireblight ratings of 2.2 and 2.3, respectively, numerous blossom clusters and shoot tips as well as some scaffold limbs on ‘Janice’ and ‘Jack Evans’ had died by May 19. By June 29, all the ‘Jack Evans’ and all but one of the ‘Janice’ Indian hawthorns had died. Between the May and June rating dates, some intensification of fireblight was noted on Majestic Beauty® and Olivia™ (data not shown). Although light blighting of the blooms and shoot tips was seen on 9 additional cultivars, the disease ratings for these plants did not significantly differ from those of the fireblight-free cultivars (Table 2). The following year, blighting one to a few bloom clusters and shoot tips was seen

Table 2. Reaction of selections and taxa of Indian hawthorn to fireblight and anthracnose at the Brewton Experiment Field, 1997 and 1998.

Cultivar	Disease			Cultivar	Disease		
	Fireblight ^z		Anthracnose ^y		Fireblight		Anthracnose
	1997	1998	1997		1997	1998	1997
Gulf Green™	0.0 ^x	0.0	1.0	‘Pinkie’	0.1	0.1	1.0
‘Snow White’	0.0	0.1	1.0	Eleanor Tabor™	0.2	0.0	1.0
Bay Breeze®	0.0	0.1	1.0	‘Heather’	0.2	0.1	1.0
White Enchantress®	0.0	0.1	1.0	Indian Princess®	0.2	0.1	1.0
Spring Rapture®	0.0	0.3	1.0	Enchantress®	0.3	0.0	1.0
Rosalinda®	0.1	0.0	1.3	Majestic Beauty®	0.6	0.0	2.7
‘Clara’	0.1	0.0	1.0	Olivia™	0.7	1.0	1.0
Springtime®	0.1	0.0	1.0	‘Janice’ ^w	3.7	—	—
Harbinger of Spring®	0.1	0.1	1.0	‘Jack Evans’ ^w	4.0	—	—
LSD (P = 0.05)	0.3	0.2	0.1		0.3	0.2	0.1

^zFireblight was rated on June 29, 1997 using a scale of 0 to 4 where 0 = no disease, 1 = one to several spurs or shoot tips dead, 2 = numerous shoot tips blighted and a few scaffold limbs killed, 3 = major portion of bush killed, 4 = bush dead.

^yAnthracnose damage was assessed on June 29, 1997 on a scale of 1 to 5 where 1 = no disease, 2 = 1 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, and 5 = 76 to 100% of leaves diseased.

^xMean separation within columns was according to Fisher’s protected least significance (LSD) test (P = 0.05).

^wJack Evans and Janice succumbed to fireblight in June 1997. No anthracnose ratings were taken.

only on the Olivia™ Indian hawthorn (Table 2). Insignificant fireblight damage was seen on an additional 8 cultivars of Indian hawthorn. In 1997 and 1998, Gulf Green™ was the only cultivar to remain free of fireblight.

In this study, fireblight severity was higher on Indian hawthorn than had been noted in previous cultivar screening trials (1, 5, 9). In 1997, 'Janice' and 'Jack Evans' Indian hawthorn, which were not previously known to be susceptible to fireblight, were virtually eradicated. The Indian hawthorn Olivia™, which suffered light but possibly objectionable blossom blight and shoot dieback, was heavily damaged by fireblight in a recent Louisiana study (6).

Anthracnose. In 1997, anthracnose appeared on the leaves of the upright cultivars Majestic Beauty® and Rosalinda® between the May and June rating dates (Table 2). Numerous diseased leaves on Majestic Beauty® were prematurely shed and the level of anthracnose-induced defoliation was noticeable. Throughout the remainder of 1997, anthracnose levels did not intensify on either cultivar. Symptoms of anthracnose were not observed on the leaves of any of the dwarf-type cultivars of Indian hawthorn.

As expected, Entomosporium leaf spot was the predominant disease observed on Indian hawthorn. The dwarf-type cultivars Indian Princess® and Olivia™ showed a consistently high level of resistance to this common and often damaging disease. Two additional cultivars, Eleanor Tabor™ and Gulf Green™, suffered significant damage only when weather patterns favored disease development. Several selections of Indian hawthorn proved so susceptible to Entomosporium leaf spot that their production and use in landscapes should cease. While the leaf spot-damaged selections were often unsightly, none succumbed to this disease. On the other hand, stands of the cultivars 'Janice' and 'Jack Evans' were eradicated by fireblight. In 1997 or 1998, unobtrusive blighting of one or more bloom clusters was seen on the majority of cultivars screened. In particular, the sensitivity of Olivia™ to fireblight seen in this and a previous

study (6) raises questions concerning the production and use of this otherwise superior cultivar of Indian hawthorn. Anthracnose proved more of a nuisance than a serious threat to the health of Indian hawthorn. Blighting of the leaves and premature leaf shed due to anthracnose was limited in only one year to the upright cultivars Majestic Beauty® and Rosalinda®. All of the dwarf Indian hawthorns remained free of the symptoms of anthracnose.

Literature Cited

1. Corley, W.L. 1980. Leafspot ratings of ten *Raphiolepis* cultivars. Proc. Southern Nursery Assoc. Res. Conf. 25:140-141.
2. Dirr, M.A. 1990. Manual of Woody Landscape Plants. 4th Ed., Stipes Publishing Co., Champaign, IL. 1007 pp.
3. Farr, D.F., G.F. Bills, G.P. Chamuris, and A.Y. Rossman. 1989. Fungi of Plants and Plant Products in the United States. The American Phytopathological Society, St. Paul, MN. 1252 pp.
4. Hagan, A.K. 1996. Controlling Entomosporium leaf spot on woody ornamentals. AL Coop. Ext. Ser. Cir. ANR-392. 2 pp.
5. Holcomb, G.E. 1998. Reaction of Indian hawthorn cultivars to Entomosporium leaf spot, 1997. Biol. Cult. Tests Cont. Plant Dis. 13:59.
6. Holcomb, G.E. 1998. First report of fire blight on Indian hawthorn cultivar Olivia in Louisiana. Plant Dis. 82:1402.
7. Olive, J.W., A.K. Hagan, and J.R. Akridge. 1996. Evaluation of selected cultivars of Indian hawthorn for resistance to Entomosporium leaf spot. Proc. Southern Nursery Assoc. Res. Conf. 41:184-187.
8. Raabe, R.D. and H.N. Hansen. 1955. Entomosporium leaf spot of *Raphiolepis*. Phytopathology 45:55.
9. Ruter, J.M. 1999. Susceptibility of 13 Indian hawthorn cultivars to Entomosporium leaf spot, 1998. Biol. Cult. Tests Cont. Plant Dis. 14:63.
10. Schubert, T.S. and L.G. Brown. 1987. Entomosporium leaf spot of *Raphiolepis* sp. Fl. Dept. of Agric. Cons. Serv., Plant Pathol. Cir. 295. 2 pp.
11. Sinclair, W.A., H.H. Lyon, and W.J. Johnson. 1987. Diseases of Trees and Shrubs. Cornell University Press, Ithaca, NY. 574 pp.
12. Tilt, K., A.K. Hagan, J.D. Williams, and J.R. Akridge. 1997. Indian hawthorn: cultivar selection is important. Proc. Southern Nursery Assoc. Res. Conf. 42:519-521.