FORUM: *Review, symposia, program and/or viewpoint papers.*

Optimizing Plant Health and Pest Management of *Lagerstroemia spp.* in Commercial Production and Landscape Situations in the Southeastern United States: A Review[1]

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Abstract

Lagerstroemia is a genus of plants comprised of deciduous shrubs or small trees native to China southward into Southeast Asia. *L. indica*, the oldest and most widespread species in cultivation in the United States, has been cultivated as an ornamental for centuries and was introduced to the Southeastern U.S. over 175 years ago. Much has been disseminated on the culture and commercial production of crapemyrtle species and cultivars; including plant forms and function, adaptability to macro and micro environment, growth and floral characteristics, and commercial production and landscape culture and maintenance. Since the introduction of *L. indica* in the United States, *L. fauriei*, *L. subcostata* and *L. limii* have also been introduced. However, since the mid 1970s, interspecific hybrids between *L. indica* × *L. fauriei* comprise the majority of new cultivar introductions. Breeding efforts have resulted in 133 commercially available cultivars as of December 2011 that include cultivars with ever improving form and flowering, new flower colors, ornamental bark, ornamental foliage, and disease tolerance. However, there is a wide range among cultivars of tolerance to key pests and diseases such as powdery mildew, *Cercospora* leaf spot, flea beetle and Japanese beetle. A large number of pests and plant pathogens also negatively affect crapemyrtle health including granulate ambrosia beetle, crapemyrtle aphid, bark scale, bacterial leaf spot, sooty mold and soil-borne root and crown diseases. This review focuses on crapemyrtle culture, in both commercial and landscape settings, with an emphasis on optimizing plant health through the discussion of major abiotic and biotic stressors and cultivar variation in tolerance to these stressors.

Index words: crapemyrtle, IPM, ornamental pests.

Species used in this study: *Lagerstroemia indica*; *Lagerstroemia speciosa*; *Lagerstroemia fauriei*; *Lagerstroemia subcostata*; *Lagerstroemia limii*; and *Lagerstroemia indica* × *fauriei*.

Significance to the Nursery Industry

Since its introduction over 175 years ago, *Lagerstroemia spp.* and cultivars have been major horticultural crops in the ornamental nursery industry, both in container and field settings. In the southeastern United States, plants are commercially grown and sold in many salable sizes from small containerized liners to large field produced specimens and may be in production at nurseries for several years before being marketed and sold. Because of the durability of crapemyrtle, plant health and pest management of crapemyrtle is sometimes overlooked in both landscape and production settings. However, there are several biotic (insects and diseases) and abiotic (e.g. low temperature) factors that can significantly and negatively impact the health of crapemyrtle and in some cases lead to mortality if not correctly identified and properly controlled. This review provides a comprehensive overview of crapemyrtle culture in production and landscape environments, focusing on environmental factors and pests that lead to significant injury. This article will be directly applicable to green industry professionals who sell, install and maintain crapemyrtle in commercial and landscape settings.

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Introduction

Plants in the genus *Lagerstroemia* L. are native to southern China, Japan, and Korea southward to Australia and Oceania (52). The scientific name *Lagerstroemia* was coined by Carl Linnaeus in 1759 to honor Magnus von Lagerstroem, a Swedish naturalist and director of the Swedish East Indies Company. Crapemyrtle derives its common name from its crepe-like, crinkled petals and the similarity of its foliage to the true myrtle (*Myrtus communis* L.) (36).

One of the most historically prevalent species in cultivation in the southeastern United States, *Lagerstroemia indica* L., has been cultivated as an ornamental in the U.S. for over 175 years (12). *L. speciosa* (L.) Pers., or Queen's crapemyrtle, has been cultivated much longer as a flowering street tree in tropical areas of the world and today is used in USDA Plant Hardiness Zone 10 southward in the U.S. (e.g. southern FL). *Lagerstroemia fauriei* Koehne, *L. subcostata* Koehne and *L. limii* Merr. have all been used in breeding programs to

introduce varied flower color, larger flower panicles, semi-evergreen foliage, disease tolerance or bark traits (52). Most recent crapemyrtle releases in the Southeast are *L. indica* × *L. fauriei* hybrids and are noted for superior tolerance to powdery mildew; a significant pathogen in the Southeast. The initial *L. indica* × *L. fauriei* hybridizations occurred in the late 1960s at the U.S. National Arboretum by Dr. Donald Egolf, with 'Natchez' and 'Muskogee' the first cultivars introduced in 1978. Since then, many other cultivars have been introduced by the U.S. National Arboretum and other public and private breeders (12) (Table 1).

Species and cultivar characteristics. Lagerstroemia species that are currently in cultivation (*L. indica* and *L. indica* × *fauriei*) are classified into three size categories: small shrubs, medium shrubs, and large shrubs to small trees (36). The small shrub category is a more recent development in reaction to increasing demand for crapemyrtle cultivars that can be incorporated into urban landscapes. Crapemyrtle is valued as a landscape plant for its prolific summer flowers, often re-blooming sporadically after an initial flush of flowers. Crapemyrtle also displays excellent heat and drought tolerance and year-round landscape interest. Flowering begins as early as May in USDA Plant Hardiness Zones 8–9 and continues into the fall in more northern areas. Sporadic re-blooming will continue in the deep south (USDA Plant Hardiness Zone 7b and south) from the end of the first bloom until frost. Each 15.3 cm (6 in) to 45.8 cm (18 in.) panicle of flowers develops on the apical growth of new stems and is composed of hundreds of 1.3 cm (0.5 in) to 5.1 cm (2 in) florets (11). Color ranges include shades of purple, lavender, white, pink and red, including 'true' red, a relatively recent development.

Lagerstroemia fauriei and its hybrid cultivars frequently possess exfoliating bark, a characteristic that adds winter interest. Bark exfoliates in early to mid-summer, revealing new underlying bark ranging in color from cream to dark cinnamon and many hues between. The bark color gradually turns to grey over the winter until it exfoliates again the following growing season (23). Foliage size varies depending on the species or hybrid of crapemyrtle. Many *L. indica* cultivars possess rounded or broadly elliptic foliage that is up to 7.6 cm (3 in) long and 3.8 cm (1.5 in) wide. Hybrid cultivars have more lanceolate foliage up to 12.7 cm (5 in) long and 7.6 cm (3 in) wide (11) while other species such as *L. subcostata* can have even larger leaves. Foliage emerges in late spring, often coinciding with *Quercus* spp., and emerges with a red casting that quickly turns dark green by full leaf expansion. A new trait in *Lagerstroemia* is foliage that emerges purple to burgundy-colored that may persist throughout the growing season, depending on cultivar. In USDA Plant Hardiness Zone 8 and north, foliage may turn bright yellow, orange or red in autumn depending on the cultivar being grown (12).

Landscape value. Crapemyrtle has become a dominant landscape plant in the southeastern United States due to its adaptability to 'poor' soil and environmental conditions and its relative ease of maintenance. Breeding programs over the last 30 years, and especially the last 10 years, have produced superior cultivars with a wide range of plant sizes and habits, improved flowering, new flower colors, ornamental bark, ornamental foliage, smaller mature size, increased disease tolerance and increased vigor. Its remarkable success as a landscape plant is largely due to the widespread usage of hybrid *L. indica* × *fauriei* cultivars.

Crapemyrtle is a premier ornamental genus for landscapes with full sun exposure. Despite a range in cultivar sizes, from small ('dwarf') shrubs to small trees, the most commonly available cultivars are best used as small trees. Generally, size has been classified as large shrub to small tree of greater than 3.1 m (10 ft), medium shrubs of 1.52m (5 ft) to 3.1 m (10 ft) and small shrubs of less than 1.5 m (5 ft) (36). The trend of large shrub cultivar availability is slowly changing as more reliably small cultivars are introduced into the marketplace. It is imperative when selecting a cultivar for landscape use that a cultivar whose growth characteristics and ultimate size fit the intended landscape is selected. Misplacement of large shrub-sized crapemyrtles will require consistent pruning that can lead to weak growth and increased pest and pathogen problems related to lush growth and poor airflow in the canopy.

Adaptability and culture. Crapemyrtle is adapted to climatic conditions commonly experienced throughout the Southeastern United States (USDA Plant Hardiness Zone 6–7 and south, depending on cultivar) (11). Established landscape plants are tolerant of extended dry periods, high heat environments and typically require little to no fertilizer application. Irrigation and fertilizer application will lead to more rapid, lush growth and increased flowering. Wet sites lead to poor growth and an increase in root pathogens. Crapemyrtle has low salt tolerance (16, 45), so it should not be irrigated with saline water or used near the coast unless it is well protected from saline conditions. Full sun will result in maximum growth and flowering. As shade levels increase, growth becomes weak and leggy, flowering diminishes and foliar pathogen incidence and severity increases. Additionally, those species (e.g. *L. indica*) and cultivars susceptible to powdery mildew should be placed in full sun locations that allow air movement to help avoid potential problems with this foliar pathogen.

Crapemyrtle in both field-production and landscape situations perform best in clay or clay-loam soils that are slightly acidic (pH 5.0 to 6.5). However, the genus will grow well in sandy soils, although irrigation and fertilization will need to be increased for maximum growth rate and plant quality. Crapemyrtle transplants easily in all soils with best transplant success achieved when plants are established in the fall through early spring in the southeastern United States. (36). Bare root or balled-and-burlapped crapemyrtles should be dug, moved and planted while dormant. In landscape situations, plants should be mulched to a depth of 7.6 cm (3 in) with a bark product or 7.6 cm (3 in) to 12.7 cm (5 in) with a pine straw. Irrigation may be required in the first growing season to aid in establishment but thereafter is not needed as it can lead to foliar (overhead irrigation) and/or root (micro-irrigation) pathogen problems.

Maintenance. Pruning should typically be conducted in late winter to early spring, depending on the physical location of the field production operation or landscape, with colder landscapes (USDA Plant Hardiness Zone 8 and north) having later pruning dates and warmer locations earlier pruning dates. Research conducted in Griffin, GA (USDA Plant Hardiness Zone 7b) indicates that pruning 'Natchez'

Table 1. Characteristics of 133 selected *Lagerstroemia* cultivars, categorized based on mature size and listed within mature size alphabetically. Only those cultivars determined to be commercially available as of December 2011 have been included.

Cultivar[z]	Flower color	Bark color	Habit
Small Shrub Category — Mature Size Under 6'			
Berry Dazzle	Fuchsia	Nondescript tan	Mounding
Bicolor	Pink and white bicolor	Nondescript tan	Mounding
Bourbon Street	Rose pink	Nondescript tan	Spreading
Cedar Red	True red	Nondescript tan	Mounding
Cherry Dazzle	Cherry red	Nondescript tan	Mounding
Chica® Pink	Medium pink	Nondescript tan	Spreading
Chica® Red	Fuschia red	Nondescript tan	Rounded
Chickasaw	Pink lavender	Nondescript tan	Compact-mounded
Chisam Fire	Red	Nondescript tan	Upright
Creole	Watermelon red	Nondescript tan	Spreading
Dazzle Me Pink	Medium pink	Nondescript tan	Mounding
Delta Blush	Light pink	Nondescript tan	Spreading
Diamond Dazzle	White	Nondescript tan	Mounding
Dwarf Purple	Purple		Mounding
Dwarf Snow	White	Nondescript tan	Mounding
Dwarf White	White	Nondescript tan	Mounding
Houston Red	Watermelon red	Nondescript tan	Mounded
Lafayette	Blush lavender	Nondescript tan	Spreading
Mardi Gras	Purple	Nondescript tan	Spreading
McFadden's Pinkie Myrtlette	Light Pink		Compact mounding
New Orleans	Deep purple	Nondescript tan	Spreading
Okmulgee	Dark red		Upright mounding
Orlando	Lavender purple	Nondescript tan	Mounded
Ozark Spring	Light lavender	Nondescript tan	Upright
Petite Embers™	Red	Nondescript tan	Upright
Petite Orchid™	Dark lavender	Nondescript tan	Upright
Petite Pinkie™	Medium pink	Nondescript tan	Rounded
Petite Plum®	Purple	Nondescript tan	Rounded
Petite Red Imp™	True red	Nondescript tan	Rounded
Petite Snow™	White	Nondescript tan	Upright mounding
Pink Blush	Light pink	Nondescript tan	Mounded
Pixie White	White	Nondescript tan	Rounded
Pokomoke	Deep rose pink	Nondescript tan	Compact- mounded
Purple Queen®	Reddish Purple	Nondescript tan	Spreading
Purple Velvet	Dark purple	Nondescript tan	Rounded
Rosy Carpet	Rose pink		Spreading
Ruby Dazzle	Ruby red	Nondescript tan	Mounding
Sacramento	Rose pink	Nondescript tan	Mounded
Snowbaby	White	Nondescript tan	Upright- rounded
Strawberry Dazzle	Neon-rose	Nondescript tan	Mounding
Sweetheart Dazzle	Dark pink	Nondescript tan	Mounding
Tightwad Red®	True red	Nondescript tan	Rounded
Tom Dodd	Orange-red		Mounding
Victor	Red	Nondescript tan	Upright
Weeping Alamo Fire	Red		Spreading
World's Fair	Red	Nondescript tan	Spreading
Medium Shrub Category — Mature Size 6' – 12'			
Acoma	White	Creamy beige	Spreading, pendulous
America	Ruby red		Upright
Baton Rouge	Deep rose red	Nondescript tan	Rounded
Bayou Marie	Pink	Nondescript tan	Rounded
Blizzard	White	Nondecsript tan	Rounded
Burgundy Cotton	White	Nondescript tan	Broad upright
Caddo	"Bubble-gum" pink	Medium orange brown	Spreading
Centennial	Purple	Nondescript tan	Rounded
Cherokee	Medium Red	Medium orange brown	Open Spreading
Cheyenne	Bright red	Medium orange brown	Rounded
Christmas Time	White	Nondescript tan	Upright vase
Conestoga	Light lavender	Nondescript tan	Spreading
Coral Sport	Coral red	Nondescript tan	Upright
Cordon Bleu	Lavender	Nondescript tan	Upright- rounded
Glowing Rose	Rose-pink		Upright - rounded
Hopi	Medium pink	Nondescript tan	Open, elliptical
Low Flame	Pinkish red	Nondescript tan	Upright rounded
Majestic Orchid™	Purple		Upright rounded
Mandi	Dark red		Mounding
Pecos	Medium pink	Rich, dark brown	Vase- shaped
Petite Snow™	White	Nondescript tan	Open, rounded

Table 1 Continued next page …

Table 1. Continued.

Cultivar[z]	Flower color	Bark color	Habit
Pink Ruffles	Medium pink	Beige	Rounded
Powhatan	Medium purple	Light brown	Upright but broad
Prairie Lace	Medium pink edged with white	Nondescript tan	Compact upright
Red Rooster	Medium red	Nondescript tan	Rounded upright
Royalty	Royal purple	Nondescript tan	Upright- rounded
Tonto	Fuschia red	Light brown	Rounded
Velma's Royal Delight	Magenta-purple	Orange-tan	Compact rounded
White Chocolate	White	Nondescript tan	Rounded
Zuni	Medium lavender	Whitish beige	Rounded
Large Shrub Category — Mature Size Under 12' – 20'			
Apalachee	Light lavender	Cinnamon orange	Upright
Candycane	Medium pink edged with white	Nondescript tan	Upright
Catawba	Violet purple	Nondescript tan	Broad
Centennial Spirit	Dark red	Beige	Stiffly upright
Christiana	Deep red	Nondescript tan	Upright- rounded
Comanche	Coral pink	Sandalwood	Upright-rounded
Cotton Ball	White		Upright vase
Cotton Candy	Bright Pink		Upright vase
Country Red	Dark red	Beige	Upright-rounded
Firebird	Dark hot pink	Nondescript tan	Spreading
Griffith Pink	Pink	Nondescript tan	Upright vase
Lipan	Reddish lavender	Whitish	Upright
Near East	Soft pink	Tan	Open, spreading
New Snow	White		Broad upright
Osage	Medium pink	Dark orange	Rounded to pendulous
Osage Blush	Light pink	Dark orange	Rounded to pendulous
Peppermint Lace	Pink edged with white	Nondescript tan	Upright-rounded
Pink Lace	Medium pink	Beige	Rounded
Pink Velour®	Hot pink	Nondescript tan	Upright
Queen's Lace	Pink-white bicolor		Upright vase
Raspberry Sundae®	Dark pink edged with white	Nondescript tan	Strongly upright
Regal Red	Red	Nondescript tan	Upright
Sarah's Favorite	White	Grey rust	Upright vase
Seminole	Medium pink	Nondescript tan	Rounded
Siren Red™	Dark red	Nondescript tan	Rounded
Sioux	Clear medium pink	Medium grey brown	Narrowly upright
Splash of Pink	Mix of white, pink and bicolor flowers	Nondescript tan	Rounded
William Toovey	Pink red	Yellow-orange	Vase-shaped
Yuma	Light lavender	Pinkish-cream	Open, rounded
Yvonne	Pink lavender		Compact globose
Small Tree Category — Mature Size Over 20'			
Arapaho	Dark red		
Basham's Party Pink	Lavender pink	Creamy beige	Rounded, vase- shaped
Biloxi	Light pink	Rich, dark brown	Open, vase- shaped
Byer's Hardy Lavender	Medium lavender		Upright rounded
Byer's Standard Red	Coral red	Orange rust	Upright
Byer's Wonderful White	White	Light beige to yellow	Upright vase-shaped
Carolina Beauty	Deep red	Nondescript tan	Upright
Choctaw	Light pink	Warm, light brown	Rounded
Dallas Red	Dark red	Nondescript tan	Upright, rounded with age
Dynamite®	True red	Light beige	Upright-rounded
Fantasy	White	Red-orange	Vase-shaped
Glendora White	White		Upright open
Hardy Lavender	Medium lavender	Reddish rust	Upright
Kiowa	White	Cinnamon brown	Vase-shaped
Miami	Dark pink	Chestnut brown	Upright vase-shaped
Muskogee	Lavender-pink	Sandalwood	Rounded
Natchez	White	Rich, cinnamon brown	Rounded
Orbyn Atkins	White	Medium orange brown	Upright vase
Potomac	Medium pink	Beige	Upright
Red Rocket®	Cherry red	Nondescript tan	Upright-rounded
Special Red	Coral red		Upright
Townhouse	White	Mahogany red	Vase-shaped
Tuscarora	Dark coral pink	Nondescript tan	Upright
Tuskegee	Dark pink	Creamy beige	Vase-shaped
Twilight	Dark purple	Nondescript tan	Upright
Watermelon Red	Watermelon red/pink	Creamy beige	Spreading
Wichita	Lavender	Rich brown	Upright-vase

[z]Cultivars identified in this table were selected based on three criteria: 1) documented in research trials in Florida (36); 2) recognized by the Crapemyrtle Society of America and trialed in The Crapemyrtle Trials of McKenney™ (48); and 3) recognized by the U.S. National Arboretum (13).

from October–December resulted in a 3C (5–6F) reduction in cold hardiness compared to pruning in January–February (22). Pruning is easier when plants are dormant as the branch structure is visible. Pruning while plants are dormant will not inhibit flower formation as crapemyrtle flowers form on new growth. Avoid annual or frequent hard pruning as this technique can spoil branch architecture that increases winter interest on crapemyrtles (36). Research has shown that tip pruning to remove spent flower panicles will promote reblooming but this technique is not practical in large plantings or low maintenance landscapes (60). To minimize winter injury, when fertilizer is necessary it is beneficial to end fertilization programs in July. Similarly, irrigation should be withheld in mid to late August. In both cases (late season fertilization and irrigation), winter injury can be substantially higher than unfertilized and unirrigated plants (40).

Form and function. Juvenile crapemyrtles characteristically develop multiple stems or in production are planted with multiple liners in a single container to achieve a multi-stem appearance. If a crapemyrtle is to be grown as a small tree or large shrub, the smallest stems should be removed, leaving one main stem for a single-trunk specimen or three to five main stems for a multi-trunked tree. It is important to select stems that are not crossing branches, rubbing against another branch, competing for sunlight, obstructing growth of other landscape plants, are too close together or causing an unbalanced canopy. If the correct (mature) size cultivar is selected for the landscape, mature plants should require minimal pruning. All crapemyrtle cultivars, especially juvenile plants, will develop suckers or water-sprouts at the base of the plant or in the root zone. The latter is enhanced if the root zone is disturbed around the plant (36). In both cases, it is imperative that herbicides not be used to control or eliminate suckers or water-sprouts. Many herbicides, including glyphosate, can be phloem-loaded and translocated throughout the plant. This can result in severe injury or death if applied to suckers or water-sprouts. On mature crapemyrtle specimens, pruning typically consists of removing small twiggy growth from the main trunks of disease-susceptible cultivars (e.g. *L. indica* cultivars). This keeps the trunk clean to allow air circulation, reducing the likelihood of powdery mildew. Many 'dwarf' crapemyrtles in the trade (particularly older 'dwarf' cultivars) are the result of genetic chimeras ('sports') and will periodically revert to a larger phenotype.

Abiotic Stress

Crapemyrtle is generally known as a resilient tree, capable of tolerating many abiotic stress factors. However, research has been conducted to identify abiotic stress factors that impact its growth. Salinity tolerance has been found to be low for *Lagerstroemia*, with salinity greater than 3.0dS·m^{-1} causing injury (16, 45). However, *Lagerstroemia* can tolerate alkaline soils, with reports indicating no reduction in growth at pH values as high as 8.2 (35, 37). Grown under drought stress, *Lagerstroemia* growth rates were less than plants grown under irrigation. However, visual plant quality was not severely affected by drought stress (8).

A significant production and landscape problem with *Lagerstroemia* has been herbicide damage. Glyphosate, the most widely used broad-spectrum post-emergence herbicide, can cause significant injury to crapemyrtles in both container and field plantings when applied to foliage or bark. Several other herbicides have been documented to cause significant damage to *Lagerstroemia*. Clopyralid, sulfonylurea, bentazon (6), imazaquin and chlorimuron (10) are among those where research has shown moderate to significant damage to *Lagerstroemia*. It is recommended that before any herbicide or pesticide is applied to *Lagerstroemia*, label instructions and rates be strictly followed.

'Rabbit tracks' is apparent as visual chlorosis and disfiguration of *Lagerstroemia* foliage in production and landscape environments. Wilson (61) determined that the likely cause of this disorder is the deficiency of sulfur, copper, iron, manganese, or zinc; with iron showing the greatest effect on an increase in 'rabbit tracks' incidence. Optimal levels of selected nutrients can be found in Table 2.

The most significant abiotic stress of Lagerstroemia is winter damage, particularly in colder climates (USDA Plant Hardiness Zone 7 and north). Injury typically manifests as shoot dieback. Depending on cultivar-location combinations, die back could be as insignificant as several cm (in) to as severe as die back to the soil line. Dead shoots should be removed in the spring immediately after the first flush of new growth. It is important to select cultivars in more northern areas with maximum cold hardiness. While many older cultivars of crapemyrtle were only cold hardy to USDA Plant Hardiness Zone 7, there are several newer cultivars hardy to USDA Plant Hardiness Zone 6, including 'Miami', 'Natchez', 'Apalachee', 'Hopi' (40, 41), 'Biloxi', 'Acoma', 'Comanche', 'Lipan', 'Osage', 'Tonto', 'Tuscadora', 'Catawa', 'Hardy Lavender' and 'Regal Red'; with *L. indica* × *fauriei* overall exhibiting greater cold hardiness than *L. indica* (9, 14, 40). However, it is important to select a microclimate in northern regions, even when growing more cold hardy cultivars, that protects the plants from direct northern exposure.

Table 2. Typical foliar concentrations reported for macro- and micro-nutrients measured in recently mature leaves collected at mid-season from that current season's growth of *Lagerstroemia*.

Macronutrient	(% dry weight)
Nitrogen[z] (N)	1.10– 3.99
Phosphorus[y] (P)	0.29– 0.36
Potassium[y] (K)	1.08– 1.75
Calcium[y] (Ca)	1.16– 1.36
Magnesium[y] (Mg)	0.76– 0.78
Sulphur (S)	not reported
Micronutrient	**(μg·g^{-1})**
Boron (B)	not reported
Chloride (Cl)	not reported
Copper[y,x] (Cu)	4.1 – 5.1
Iron[y,x,w] (Fe)	66 –106
Manganese[y,x] (Mn)	336 –366
Molybdenum (Mo)	not reported
Zinc (Zn)[y,x]	66 – 91

[z](43, 44, 49)

[y](43)

[x]Leaf tissue analyses of Cu, Mn, and Zn may not be reliable indicators of plant nutritional status because *Lagerstroemia* foliage in commercial nurseries may be exposed to fungicides and nutrient solutions containing trace elements, and surface level contamination may persist even after leaves are washed.

[w]Surface contamination of foliage from soil and presence of unavailable (physiologically inactive) and immobile iron in plant tissues limits the informative value of iron measured by foliar analyses.

Cold tolerance of crapemyrtle varies widely depending on time of measurement and growing environment. In container plantings, cold hardiness ranges from –3C (26.6F) on October 31 and –9C (48.2F) on April 19 to –24C (–11.2F) on January 9. Field-grown plants exhibit much greater tolerance to cold temperatures compared to container grown plants in spring and fall and slightly greater cold tolerance mid-winter. Field-grown cold tolerance ranged from –12C (10.4F) on October 31 and April 19 to –25C (–13F) on January 9. All measurements were taken in USDA Plant Hardiness Zone 7b (Griffin, GA) (42).

Pest Management — Insects

Crapemyrtles have relatively few insect pests. Those of primary importance include the crapemyrtle aphid, *Tinocallis kahawaluokalani* Kirkaldy; the Japanese beetle, *Popillia japonica* Newman; flea beetles, mainly *Altica* species and granulate ambrosia beetles, *Xylosandrus crassiusculus* Motschulsky. Emerging pests include a bark scale in some parts of the country.

Granulate ambrosia beetles. (formerly Asian ambrosia beetles), *Xylosandrus crassiusculus* are small (1.5–3.0 mm long), reddish-brown beetles currently placed in the insect order Curculionidae. Females are larger than males. The head of the insect is hidden from view when looking down from above. Females fly while males do not. The pest has a wide geographic distribution and has been present in the U.S. since the 1970s when it was detected near Charleston, SC (5). Larvae are pale and legless with well-developed head capsules. Females typically bore into small caliper twigs, branches or trunks of a wide diversity of plant hosts including crapemyrtle. They introduce a fungus into the gallery system that will house their offspring. Beetles feed on this 'farmed' ambrosia fungus, not on the surrounding wood. The combined injury of insect tunneling and fungus blocking vascular tissue can kill even previously healthy trees. Stressed trees are more vulnerable to attack, but even apparently healthy trees can succumb to ambrosia beetle induced injury. Evidence of infestation includes failure to flush leaves in the spring and 'toothpick sawdust frass' exuding from small holes in affected plant parts.

Females fly in late winter and early spring, with flight activity as early as February and peak flight in March or April depending on location (Table 4). Small numbers of beetles continue to be present throughout the summer. Monitoring first flight of granulate ambrosia beetles can be accomplished with traps that use ethyl alcohol as an attractant. Traps can be purchased or constructed from readily available, inexpensive materials like soda bottles or solo cups. A discussion of trap types and construction can be found in Oliver et al. (47). Trees should be managed to minimize plant stress and monitored frequently during flight periods. Trunk sprays with labeled products have been found to be effective when applied in time to prevent beetles from boring into trees. Once beetles have established within the tree, they are not vulnerable to insecticide control. Infested trees should be removed and destroyed as they can serve as a source of infestation to surrounding trees. Effective ambrosia beetle management begins with monitoring adult flight. Monitoring programs for ambrosia beetles in ornamental nurseries should focus on traps baited with ethanol alone at a release rate of at least 275 mg·day^{-1} (0.01 oz·day^{-1}) at 20C (68F) (53). Optimal trap height of *X. germanus* and *X. crassiusculus* appears to be 0.5 m (1.6 ft) and < 1.7 m (5.6 ft) respectively to capture first adult flight (54). When adult beetles are captured growers can protect their trees by spraying susceptible tree trunks with labeled products every 2–4 weeks.

Flea beetles. Altica spp., can become serious pests of crapemyrtles in production, but have not been a problem on established landscape plants (50). Adult beetles are metallic blue-green with their hind legs adapted for jumping. Adult feeding can result in very rapid defoliation of crapemyrtles. Larvae of the species attacking crapemyrtle develop on herbaceous plants within the plant families *Onagraceae* and *Lythraceae* (51), but do not develop on crapemyrtle. Females deposit small orange eggs on leaves of herbaceous hosts. Larvae complete development through three instars on these hosts before dropping to the ground to pupate in the soil. Adult beetles then emerge the following spring and are opportunistic feeders on newly flushed crapemyrtles. Adult beetles chew small holes in leaves leaving a shot-hole like effect and can completely defoliate new growth. Beetles may have two to three generations per year.

Management decisions are complicated by the difficulty in identifying species and an inadequate understanding of host plant relationships (38, 39, 55). There occasionally seems to be some benefit to removing potential weedy hosts (e.g., cut leaf evening primrose) to prevent spread to vulnerable crapemyrtles. The beetles can be readily controlled with properly timed insecticide sprays. Scouting in early spring (Table 4) can help detect populations before they build to an economic damage threshold. Resistance to *Altica* spp. among crapemyrtle cultivars has been identified (38, 50) (Table 3). Highly susceptible cultivars may serve as first indicators of a pest problem, while other, more resistant, cultivars will require more scouting time.

Japanese beetle. Popillia japonica adults attack flowers, fruit and foliage of more than 300 species of plants, including crapemyrtles that are among their most preferred species. Since its introduction in 1916 via infested nursery stock, it has become one of the most damaging pests in the eastern U.S. (24). The adults of this scarab beetle skeletonize leaves and feed heavily on flowers. The adult beetles are 8 to 11 mm (0.3 to 0.4 in) long and metallic green and copper-brown in color. They are active day fliers that disperse readily over long distances. This beetle has an annual life cycle, requiring one year to complete development (egg to egg). The majority of the life cycle is spent underground as a larva, feeding on the roots of turfgrass and other susceptible plants. Eggs, as many as five dozen per female, are deposited into moist soil, hatch and develop through three instars. The winter is spent as a third instar larva with pupation occurring in the spring. Adult beetles emerge from the ground in early summer (Table 4), usually following a rainfall event. They are highly mobile and gregarious, capable of rapidly defoliating susceptible plants. A range in susceptibility has been identified among crapemyrtles, with some cultivars demonstrating moderate to high levels of tolerance (50).

Traps that use both a floral lure and sex attractant can be used to indicate first flight of Japanese beetles. They should be placed at least 60.96 m (200 ft.) away from plants that you are trying to protect. The attractant in the traps can attract beetles to nearby plants as well as to the traps and

Table 3. Disease and insect susceptibility among *Lagerstroemia* cultivars. Blanks indicate no data for the cultivar – pest complex. If no data is available for a cultivar, it has been omitted from this listing.

Cultivar	Powdery mildew resistance[z]	Cercospora leaf spot resistance[y]	Flea beetle resistance[x]	Japanese beetle resistance[w]
Acoma	Excellent	Fair	Resistant	Moderately resistant
Apalachee	Good	Very good	Moderately resistant	Moderately susceptible
Arapaho			Moderately resistant	
Basham's Party Pink	Good	Very good		
Baton Rouge	Poor	Fair		
Bayou Marie	Poor			
Berry Dazzle	Excellent			
Biloxi	Good	Very poor	Moderately resistant	Moderately susceptible
Blizzard	Fair			
Bourbon Street	Fair			
Burgundy Cotton™	Fair	Poor		
Byer's Wonderful White	Good	Very poor	Moderately susceptible	Moderately susceptible
Byer's Standard Red	Good	Good	Moderately susceptible	Moderately susceptible
Caddo	Good	Fair		
Candycane	Fair			
Carolina Beauty	Very poor	Poor	Moderately susceptible	Moderately susceptible
Catawba	Fair	Fair	Susceptible	Moderately resistant
Cedar Red			Moderately susceptible	
Centennial	Very good	Good	Moderately susceptible	Moderately susceptible
Centennial Spirit	Good	Fair	Moderately susceptible	Moderately susceptible
Cherry Dazzle	Excellent			
Cheyenne			Moderately resistant	
Chica® Pink	Poor			
Chica® Red	Poor			
Chickasaw	Excellent		Moderately resistant	Moderately resistant
Choctaw	Good	Fair	Moderately susceptible	Moderately resistant
Chisam Fire	Unknown			
Christiana	Good			
Comanche	Excellent	Poor	Moderately susceptible	Moderately resistant
Conestoga	Poor			
Coral Sport	Fair			
Cordon Bleu	Very poor	Poor		Moderately resistant
Country Red	Poor	Fair	Moderately susceptible	
Creole	Unknown			
Dallas Red	Fair			
Dazzle Me Pink	Excellent			
Delta Blush	Fair	Poor		
Diamond Dazzle	Excellent			
Dwarf Snow	Fair			
Dwarf White	Fair			
Dynamite®	Very good	Fair	Susceptible	Moderately susceptible
Fantasy	Excellent	Very good	Moderately resistant	
Firebird	Fair			
Glendora White	Excellent	Good		
Hardy Lavender	Good	Poor	Moderately susceptible	Moderately susceptible
Hope			Moderately susceptible	Moderately susceptible
Hopi	Good	Poor	Susceptible	Moderately susceptible
Houston Red	Good	Good		
Kiowa	Excellent			
Lafayette	Good	Good		
Lipan	Excellent	Fair	Resistant	Moderately resistant
Low Flame	Fair		Moderately susceptible	
Majestic Orchid	Unknown			
Mandi	Fair	Poor		
Mardi Gras	Good	Very good		
McFadden's Pinkie Myrtlette	Excellent			
Miami	Excellent	Poor	Moderately resistant	Moderately susceptible
Muskogee	Good	Poor	Resistant	Moderately resistant
Natchez	Excellent	Poor	Resistant	Moderately susceptible
Near East	Excellent	Fair		
New Orleans	Very good	Good		
New Snow	Good			
Okmulgee	Fair		Moderately susceptible	
Orlando	Very good	Very good		
Osage	Excellent	Very good	Resistant	Moderately resistant
Osage Blush	Excellent			
Ozark Spring	Poor		Moderately susceptible	Moderately susceptible
Pecos	Excellent	Fair	Moderately susceptible	Moderately susceptible
Peppermint Lace	Good	Poor		

Table 3 Continued next page …

Table 3. Continued.

Cultivar	Powdery mildew resistance[z]	Cercospora leaf spot resistance[y]	Flea beetle resistance[x]	Japanese beetle resistance[w]
Petite Embers™	Fair			
Petite Orchid™	Fair			
Petite Pinkie™	Fair			
Petite Plum®	Fair			
Petite Red Imp™	Fair			
Petite Snow™	Fair			
Pink Blush	Fair	Fair		
Pink Lace	Fair	Good		
Pink Ruffles	Fair		Moderately susceptible	
Pink Velour	Good	Poor	Moderately susceptible	Moderately resistant
Pixie White	Fair	Fair		
Pocomoke	Excellent	Excellent	Moderately resistant	Resistant
Potomac	Fair	Fair	Moderately susceptible	Moderately resistant
Powhatan	Fair	Poor	Moderately susceptible	Moderately susceptible
Prairie Lace	Fair	Good		
Purple Velvet	Very poor	Poor		
Raspberry Sundae®	Poor	Poor	Moderately susceptible	Moderately susceptible
Red Rocket®	Good	Good	Moderately susceptible	Susceptible
Red Rooster	Excellent			
Regal Red	Poor	Fair	Moderately susceptible	Susceptible
Royalty	Very poor			
Rosy Carpet	Good			
Ruby Dazzle	Good			
Sacramento	Fair	Good		
Sarah's Favorite	Excellent	Fair	Moderately resistant	
Seminole	Fair	Fair	Moderately susceptible	Moderately susceptible
Siren Red™	Good			
Sioux	Excellent	Fair	Moderately resistant	Moderately susceptible
Snowbaby	Poor			
Special Red	Fair			
Splash of Pink	Fair			
Strawberry Dazzle	Excellent			
Sweetheart Dazzle	Excellent			
Tightwad Red®	Unknown		Susceptible	
Tonto	Good	Excellent	Resistant	Moderately resistant
Townhouse	Excellent			
Tuscarora	Excellent	Excellent	Resistant	Moderately susceptible
Tuskegee	Excellent	Excellent	Moderately resistant	Moderately resistant
Twilight	Good	Good	Moderately susceptible	
Velma's Royal Delight	Fair	Good	Moderately susceptible	Moderately susceptible
Victor	Fair	Fair	Moderately susceptible	Moderately susceptible
Watermelon Red	Fair			
Weeping Alamo Fire	Fair			
White Chocolate	Fair			
Wichita	Excellent	Good	Moderately resistant	Moderately resistant
William Toovey	Poor	Fair	Moderately susceptible	Moderately susceptible
World's Fair	Excellent	Good		Moderately susceptible
Yuma	Excellent	Fair	Moderately resistant	Moderately susceptible
Yvonne	Good			
Zuni	Fair	Good	Moderately susceptible	

[z]Excellent, powdery mildew was not observed in two or more evaluations; Very good, very low level of disease in two or more evaluations; Good, low level of disease in two or more evaluations; Fair, moderate disease level in at least one evaluation; Poor, high disease level in at least one evaluation; Very poor, high disease level in two or more evaluations (20, 27, 30, 31, 33, 36).

[y]Excellent, *Cercospora* leaf spot was not observed in one or more evaluations; Very good, very low level of disease in one or more evaluations; Good, low level of disease in two or more evaluations; Fair, moderate disease level in at least one evaluation; Poor, high disease level in at least one evaluation; Very poor, high disease level in two or more evaluations (20, 27, 29, 31, 32, 33, 34).

[x]Resistant, no damage in two or more trials; Moderately resistant, low damage in two or more trials or no to low damage in only one trial; Moderately susceptible, high damage in two or more trials, or moderate to high damage in one trial; Susceptible, highest damage in two or more trials (50).

[w]Resistant, lowest damage in one or more trials; Moderately resistant, low damage in one or more; Moderately susceptible, high damage in one or more trials; Susceptible, highest damage in one or more trials (7, 49).

are thus ineffective for managing beetles, but do serve as a monitoring tool. Predation by birds, small mammals and generalist insect predators can reduce populations of immature Japanese beetles. Two wasp species (*Tiphia vernalis* and *T. popilliavora*) parasitize larvae, and a tachinid fly (*Hyperecteina aldrichi*) attacks adult beetles. The bacteria *Bacillus popilliae* exclusively attacks Japanese beetle, but is recommended for large scale, regional application rather than individual site applications. Microscopic entomopathogenic nematodes occur naturally in the soil, and, together with a symbiotic bacterium, can ultimately kill grubs by means of septicemia. Nematodes that have been shown to be most

Table 4. Life stage activity of primary pests of nursery-grown crapemyrtle based on normal emergence in USDA Plant Hardiness Zone 8. It is important to note that the activity of each pest may vary outside of USDA Plant Hardiness Zone 8 and in cooler or warmer microclimates within USDA Plant Hardiness Zone 8.

Pest/Disease	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Granulate ambrosia beetle												
Altica sp. flea beetles												
Japanese beetle adults												
Crapemyrtle aphid												
Powdery mildew												
Cercospora leaf spot												
Bacterial leaf spot												

effective against Japanese beetle grubs are *Steinernema glaseri* and *Heterorhabditis bacteriophora*. The latter is commercially available.

Japanese beetles on susceptible plants can be controlled with foliar applications of short-residual insecticides that require repeated applications to maintain uninjured plants during adult flight periods. Systemics can provide longer residual control. Follow the United States Domestic Harmonization Plan when shipping nursery stock from areas that may be infested with Japanese beetles to beetle-free areas (56).

Crapemyrtle aphid. Tinocallis kahawaluokalani, is a crapemyrtle specific pest and will not affect damage on any other plant material. They are native to Southeast Asia, but occur almost everywhere that crapemyrtle is grown. These aphids are less than 2 mm (0.08 in) in length and yellowish-green with black spots or spikes (nymphs). Adults have two large black tubercles on the upper surface of the abdomen and wings with black markings. They may, if present in high numbers, render the plant unsightly with their direct injury resulting in yellowing leaves, premature leaf drop and the sooty mold that will develop on the honeydew secreted by feeding aphids. They are also a magnet for myriad generalist natural enemies that are attracted to the aphids for food (predaceous lady beetles, green and brown lacewings and syrphid flies) and provide resources via the honeydew for parasitic wasps.

Overwintering eggs hatch and develop through four instars requiring from 5 to 14 days, depending on temperature (4). Adults can live as long as two weeks and may produce from 50–150 progeny. Aphid populations can increase very rapidly because of their high reproductive capacity and short development times. During the summer, aphids give live birth to aphid nymphs, further increasing their capacity for rapid population growth (Table 4). Close monitoring is required so that small populations do not escape detection and increase to economically damaging levels.

While crapemyrtle aphids can be more readily tolerated in the landscape, serving as a reservoir to conserve and increase natural enemies, their presence in the nursery is more problematic. Monocultures of crapemyrtles foster increases in aphid numbers that, with their associated sooty mold, can render plants unsalable. Plants can be treated with contact or systemic insecticides to control population numbers and oftentimes insecticides applied to control another pest are capable of controlling this pest as well.

Bark scale. An emerging pest was discovered in 2010 in northern Texas. It was initially thought to be a race of azalea bark scale, but subsequent molecular analysis is suggesting a species unique to crapemyrtle and probably also accidentally introduced. Current evidence suggests that the scale may be a migrant from Asia, *Eriococcus lagerostroemia*, that is common on timber trees of *L. indica* in Japan and China. Black sooty mold and sticky exudate on leaves and bark may indicate infestation. The insects are white to gray in color and ooze pink when 'squished'. There may be numerous pink eggs under female scale covers. Dormant oil applications in winter or systemic insecticides applied as a drench to the root zone have shown good control when applied between the months of May and July (59).

Host plant resistance: Insects. There are some crapemyrtle cultivars that have been shown to have at least moderate levels of resistance to crapemyrtle aphid: 'Acoma', 'Apalache', 'Biloxi', 'Caddo', 'Centennial Spirit', 'Choctaw', 'Comanche', 'Fantasy', 'Hopi', 'Lipan', 'Miami', 'Muskogee', 'Natchez', 'Osage', 'Pecos', 'Sioux', 'Tuscarora', 'Tuskegee', 'Victor', 'Wichita', 'Yuma', 'Tonto' and 'Zuni' (25, 46). Higher aphid populations are often observed on *L. indica* × *L. faurei* cultivars than on cultivars of pure *L. indica* decent. Unfortunately, these are often the cultivars with improved powdery mildew resistance. Cultivars with a tall mature plant height were more susceptible than medium or dwarf cultivars. Cultivars demonstrating resistance to both flea beetle and Japanese beetle often have *L. faurei* in their parentage, such as 'Acoma', 'Chickasaw', 'Lipan', 'Pocomoke' and 'Tonto' (7, 50) (Table 3).

Pest Management — Diseases

Crapemyrtles are affected by relatively few diseases. The most damaging diseases are powdery mildew, caused by *Erysiphe australiana* (McAlpine) U. Braun & S. Takamatsu, and Cercospora leaf spot, caused by *Pseudocercospora lythracearum* (Heald & Wolf) Liu & Guo. Several other diseases have been reported or are increasing in disease incidence including a bacterial leaf spot, caused by *Xanthomonas* sp. Ride. Although not technically a disease of crapemyrtle, sooty mold can be a serious aesthetic problem.

Powdery mildew. Powdery mildew is a fungal disease caused by *Erysiphe australiana* (syn. *Erysiphe lagerstroemiae*) is the most damaging and widespread disease on *Lagerstroemia* species and hybrids wherever crapemyrtles are grown. Breeding programs pioneered by the U.S. National Arboretum using *L. indica* × *L. fauriei* hybridizations have produced numerous powdery mildew tolerant cultivars (Table 3). Other public and private breeding programs have

expanded powdery mildew tolerant cultivar selections. Most cultivars in current crapemyrtle production carry some level of powdery mildew tolerance. Additionally, most landscape plantings now include powdery mildew tolerant cultivars, thus decreasing powdery mildew incidence over the last 20 years.

The powdery mildew pathogen overwinters as mycelium within dormant crapemyrtle leaf buds (57). The teleomorph (sexual stage) of this pathogen rarely develops and is often not seen. Signs of powdery mildew infection often initially develop on lower foliage and suckers at the base of the plant. Small, white, powdery patches of fungal hyphae and spores are easily seen on foliage. Patches coalesce and may cover entire leaves, new shoots, and flower buds. Powdery mildew typically develops in late spring and fall and is associated with warm day and cool night temperatures and high relative humidity (Table 4). Severe powdery mildew infection can distort newly developing leaves, shoots and flowers. Infected flower buds may not open, and severely infected leaves and buds may drop prematurely (1).

Plant disease resistance/tolerance is the most important and sustainable disease management option for powdery mildew. Breeding programs have effectively incorporated powdery mildew tolerance to produce commercially available and desirable cultivars. Powdery mildew can be effectively managed by fungicide applications when applied preventively or at the first sign of disease. Disease severity may be reduced by high nitrogen applications. Application rates of 136.10 to 272.16 kg (300 to 600 lbs) of nitrogen per acre significantly reduce powdery mildew and *Cercospora* leaf spot incidence and defoliation compared to lower rates of 8.5 to 34.0 kg (18.8 to 75 lbs) per acre (17). However, 136.1 to 272.2 kg (300 to 600 lbs) of nitrogen per acre is substantially more than the recommended rate of 18.14 to 31.75 kg (40 to 70 lbs) per acre per year for residential and commercial landscapes. Therefore, the reduction in disease incidence is not acceptable given increasing concerns over nitrogen contamination of surface and ground water.

Cercospora leaf spot. Leaf spot disease caused by the fungus, *Pseudocercospora lythracearum* (syn. *Cercospora lythracearum*) is the second most damaging disease of crapemyrtle (2). Leaf spots develop in mid-summer through the fall during wet, humid weather (Table 4). Symptoms of *Cercospora* leaf spot include tan to dark brown spots randomly scattered on yellow to red discolored leaves. Infection often begins on the lower leaves and progresses upward through the plant. Infected leaves drop prematurely from the plant and severely affected plants can be defoliated prior to frost. Although *Cercospora* leaf spot does not significantly reduce the health of the plant, it does affect fall leaf color display. A number of new crapemyrtle cultivars exhibit tolerance to *Cercospora* leaf spot (Table 3). However, only a small fraction of older cultivars have been screened for susceptibility to this disease. More research in this area is needed.

Plant disease resistance is the most important and sustainable disease management option for *Cercospora* leaf spot. To date, breeding efforts for leaf spot resistance is negligible and in its infancy. Only a few researchers have screened cultivars for susceptibility to *Cercospora* leaf spot and most have been in conjunction with powdery mildew screening programs. However, moderate to high tolerance levels have been discovered in some cultivars (18, 31, 33). More research needs to be done to incorporate *Cercospora* leaf spot resistance into cultivars. Fungicides applied in mid-spring to early summer (early May to mid-July in USDA Plant Hardiness Zone 8) effectively reduced leaf spot incidence and defoliation compared to non-treated trees (17, 19).

Bacterial leaf spot. Since 2009, a leaf spot caused by an unidentified *Xanthomonas* bacterium species has been seen in the southeastern United States (University of Georgia Plant Disease Clinic Annual Report, unpublished) (Table 4). The bacterium causes dark brown, angular to irregularly shaped, oily-looking spots surrounded by a yellow halo. Infected leaves often turn yellow to red and may drop prematurely. The disease is most often seen on lower leaves of nutrient-stressed and tightly-spaced plants. The significance and geographic distribution of this disease is not currently known. Fungicides have not been evaluated for bacterial leaf spot management and it is doubtful that fungicide applications will provide adequate control.

Sooty mold. Sooty molds are fungi within the genera *Capnodium*, *Chaetothyrium*, *Metacapnodium*, and *Scorias* (58). They are not plant pathogens. The fungi are saprobes that grow on plant surfaces and live on sugary insect secretions, most commonly honeydew from the crapemyrtle aphid (*T. kahawaluokalani*). Sooty mold colonies consist of darkly pigmented hyphae and spores of the fungus. Colony shape and size can vary depending upon species and level of infestation. Colonies may be thin, black, irregular patches or they may form a dense covering. Heavy accumulation of sooty mold can interfere with plant photosynthesis; however, it is not known to negatively affect plant growth.

Minor diseases. Crapemyrtles can be affected by root and crown diseases in nurseries including root rot diseases caused by *Pythium* spp. Pringsh. and *Phytophthora* spp. de Bary and web blight caused by *Rhizoctonia spp.* DC (15). In landscapes, infection by *Armillaria tabescens* (Scop.) Emel (mushroom root rot) can cause root decay, particularly in older plantings (3). The root diseases are of minor importance as infection is often seen sporadically and is often based upon poor nursery production practices and root injury and stress within landscapes. Several fungi have also been reported causing leaf spot diseases in the southern United States including *Cylindrocladium scoparium* Morg. and *Phyllosticta lagerstroemiae* Ellis & Everh. However, incidence of these leaf spot diseases is sporadic and usually causes insignificant damage. Branch and stem cankers caused by *Botryosphaeria spp.* Ces. & De Not. may also occur on weakened or injured plants (15).

Host plant resistance: Disease. The best approach to manage crapemyrtle diseases is to utilize cultivars that show good resistance to both powdery mildew and *Cercospora* leaf spot such as 'Apalachee', 'Basham's Party Pink', 'Caddo', 'Fantasy', 'Osage', 'Pokomoke', 'Sarah's Favorite', 'Tonto', 'Tuskegee', and 'Tuscarora' (21, 26, 28, 29, 33).

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