Factors Influencing Honeybee (*Apis mellifera* L.) Visits to Crepe Myrtle (*Lagerstroemia* sp.)[1]

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Abstract

Honeybees (*Apis mellifera* L.) are important pollinators and will selectively forage on crepe myrtle (CM) during the summer months. Unfortunately, CM pollen can become contaminated with pesticides used to control insects, especially crepe myrtle bark scale (*Acanthococcus lagerstroemiae* Kuwana). An experiment was conducted in July and August of 2019 and 2020 to compare honeybee visits to CM among four cultivars ('Natchez', 'Tuscarora', 'Ebony Fire', and 'Pocomoke') at an isolated location, and within a single cultivar series (Ebony) near other pollinator-friendly plants. 'Natchez' had the most honeybee visits per tree, averaging 1.4 visits per 75 seconds per tree per day in 2019 and 1.2 visits per 75 seconds per tree per day in 2020, followed by 'Tuscarora' with 0.8 and 0.4 honeybee visits per 75 seconds per tree per day, in 2019 and 2020, respectively. In 2020, there was a significant, moderate correlation ($P < 0.001$, $r = 0.51$) between bloom number and honeybee visits, with 'Natchez' (158.9) and 'Tuscarora' (148.2) having more average blooms per tree than 'Ebony Fire' (35.6) and 'Pocomoke' (35.7). Landscape environment and proximity to pollinator-friendly plants did not affect honeybee visits. CM are an important foraging resource for honeybees in the summer, and honeybees have a strong preference for cultivars with large, productive bloom clusters.

Index words: pollinators, crepe myrtle bark scale, *Acanthococcus lagerstroemiae*, crepe myrtle.

Species used in this study: Crepe myrtle, *Lagerstroemia indica* L.; *Lagerstroemia* × *faurei*; Honeybee, *Apis mellifera* L.; American bumblebee, *Bombus pensylvanicus* De Geer.

Significance to the Horticulture Industry

Crepe myrtle is one of the most important landscape shrubs and small trees for southern landscapes. First identified in Richardson, TX in 2004, a new insect, crepe myrtle bark scale (CMBS) has become a serious pest of crepe myrtle throughout the southeastern U.S., and control methods are limited to either mechanical removal in late winter using either a soapy water scrub or power washing, or the use of systemic insecticides that are translocated throughout the plant, including the pollen. This study confirms the preferential feeding habits of honeybee on crepe myrtle flowers. Honeybees prefer heavy blooming crepe myrtle cultivars, and worker bees will collect and feed on crepe myrtle pollen throughout the bloom cycle, starting shortly after bloom opening and continuing until no blooms remain. During the bloom period, honeybees will visit crepe myrtles preferentially over other pollinator-friendly plants. Understanding these feeding habits will allow informed treatment decisions that provide control of pests while minimizing damage to honeybees.

[1]Received for publication June 21, 2021; in revised form October 14, 2021. This project was supported by the USDA-NIFA-SCRI program, award number 2014-70006-22632, the Texas A&M University-Commerce Presidential Scholars program, and the Houston Livestock Show and Rodeo. We thank Tree Town, USA and J. Berry Nursery for plants used in this study. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the authors, Texas A&M University, Texas A&M AgriLife Extension, Texas A&M University-Commerce, or the U.S. Department of Agriculture (USDA), and does not imply its approval to the exclusion of other products or vendors that also may be suitable.

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Introduction

Crepe myrtle (*Lagerstroemia* sp.) are important plants for southern U.S. landscapes, adding vibrant color in the summer as a large shrub or small tree. *Lagerstroemia indica* L. cultivars range in mature height from 0.8 to 6 m (2 to 20 ft), have a tan bark color, green or deep burgundy foliage with yellow, orange, and red fall color, and individual flowers approximately 2.5 cm (1 inch) across and typically pink in color, though white, lavender, and red cultivars are available (Arnold, 2008). Crepe myrtle hybrid (*Lagerstroemia indica* × *L. fauriei*) cultivars are typically taller, reaching up to 9 m (30 ft), have a cinnamon bark color, green leaves with yellow fall color, and flower size and color range similar to *L. indica*.

Even though their flowers lack nectar, CM are an important foraging source for bees, providing pollen when other flowers are scarce (Riddle and Mizell 2016). Crepe myrtle produce two types of anthers and pollen (Nepi et al. 2003). Six anthers produce pollen for fertilization ("real pollen"), are bluish-green in color and found on long, curving filaments on the outer perimeter of the bloom, opposite the petals. "Feed pollen" is used as food to entice honeybees and other pollinators and is formed in the 30-40 stamen found in the flower center. These anthers are bright yellow in color and produce pollen much higher in fructose than the "real pollen." (Nepi et al. 2003, Table 1).

The stimulus that brings honeybees to CM is unclear. Existing understanding of honeybee behavior suggests a preference for blue and white flowers (Waddington and Gottlieb 1990). Therefore, honeybees should have a preference for white flowering cultivars (e.g. 'Natchez', 'Acoma', 'Byer's Wonderful White'). However, when presented CM with white, pink, lavender, and red blooms, no preference based on color could be identified (Riddle and Mizell 2016), with preference based solely on pollen availability. Honeybees often choose simpler flowers that offer a shorter handling time and increasing net reward (Sanderson et al. 2006, Waddington and Gottlieb 1990). Feed pollen in CM is easily attained and plentiful during a time when floral resources are limited (Couvillon et al. 2014, Lau et al. 2019).

Unfortunately, a new pest, crepe myrtle bark scale (CMBS) (*Acanthococcus lagerstoemiae* Kuwana), has emerged and infested plants throughout the southeastern U.S. Control of this pest is difficult, and the effective controls include either mechanical removal or the use of neonicotinoid insecticides (e.g. imidicloprid or dinotefuran) applied as a drench in late spring or early summer (Bledsoe et al. 2020, Gu et al. 2014, Merchant et al. 2014). Neonicotinoids are effective and popular insecticides because of a relatively low application rate, the ability to apply to the roots rather than foliar applications, and systemic translocation, providing whole plant protection. However, neonicotinoids can cause severe injury to non-target organisms, especially pollinators (Bonmatin et al. 2014). Because neonicotinoids are very toxic to bees (LD_{50} $\sim$2 ng / bee), either the direct ingestion or the concentrated effects of accumulated hive pollen can have serious implications for hive health (Bonmatin et al. 2014, Codling et al. 2016). Loss of colonies through pollen consumption during overwintering may stem from honeybees consuming neonicotinoid-contaminated nectar and pollen (Codling et al. 2015).

Because treatment for CMBS may cause potential injury to honeybees, providing alternative pollen sources could help minimize the injury by minimizing CM pollen in the diet. While CM is an important summer food source for honeybees in Florida and Texas, it was not in California, where bees collected pollen from 48 plant taxa across 34 plant families (Lau et al. 2019). In Texas, the Shannon-Weaver diversity index was 0.43, while in California, it was 1.03, and, while bees do tend to forage exclusively on a few pollen sources (Dimou and Thrasuvoulou 2007, Leonhardt and Bluthgen 2012), incorporating additional species richness into our landscapes can help provide additional, healthy foraging sources for bees and other pollinators, with the hope that these sources become alternative sources of feed pollen.

The purpose of this study was to identify and evaluate the foraging preferences of bees as they relate to CM, especially among cultivars and between CM and other pollinator-friendly species. Understanding honeybee foraging patterns and plant preferences can provide insight that will help minimize neonicotinoid damage by altering plant recommendations, especially in urban landscapes, to include potential alternate foraging sources, and insecticide application timing adjusted to maximize CMBS control, while minimizing damage to honeybees.

Materials and Methods

In this study, honeybees were monitored across two CM plantings, one at the Texas A&M University-Commerce Crepe Myrtle Research Garden (CMRG), and a second at the Texas A&M University-Commerce Plant Science Center (PSC), approximately 0.5 km (0.3 miles) south of the CMRG. The CMRG is an isolated area, with no other ornamental flowering plants within 0.5 km (0.3 mile). CM beds are bordered by unimproved turf, consisting primarily of bahiagrass (*Paspalum notatum* Fluegge), maintained at 5 cm (2 in), and the area is surrounded by woods, consisting primarily of post oak (*Quercus stellata* Wangenh), eastern red cedar (*Juniperus virginiana* L.), and hackberry (*Celtis laevigata* Willd.). CM cultivars evaluated were 'Natchez', 'Tuscarora', 'Ebony Fire', and 'Pocomoke', with four beds of each cultivar and six CM trees per bed for a total of 24 for each cultivar. 'Natchez' (*Lagerstroemia* × *fauriei* 'Natchez') and 'Tuscarora' (*Lagerstroemia indica* L. 'Tuscarora') have a mature height of 6 to 9 m (20 to 30 ft) and a mature width of 4.5 to 6 m (15 to 20 ft). 'Natchez' has large white blooms, while 'Tuscarora' flowers are a deep pink. 'Ebony Fire' has a mature height between 3.5 and 4.5 m (12 to 15 ft), a mature width of 2.5 to 3.5 m (8 to 12 ft), and deep red blooms. 'Pocomoke' is a dwarf crepe myrtle with a mature height and width of 1 m (3 ft), with deep rose pink flowers.

Beds were 2.4 m (8 ft) wide and sufficiently long to provide adequate spacing. 'Natchez' and 'Tuscarora' were spaced 3 m (10 ft) on-center; 'Ebony Fire' were spaced 2.4 m (8 ft) on-center, and 'Pocomoke' were planted 1 m (3.2 ft) on-center. All CM at this site were planted in 2018 and fully established at study initiation. Because of differences in plant size and potential shading issues, the site was set up as a split-plot randomized complete block design with four blocks and six of each cultivar assigned to cultivar-specific sub-plots within each block.

The PSC planting consists of 24 CM in total in four beds and six CM per bed. When planted in 2012, cultivars included 'Centennial Spirit', 'Ebony Embers', 'Ebony Fire', 'Ebony Flame', 'Ebony Glow', and 'Ebony and Ivory'. Unfortunately, 'Ebony and Ivory' grew poorly in the location and was replaced with 'Tonto' in 2018. Beds were 2.4 m (8 ft) wide and trees planted 2.4 m (8 ft) on-center. Beds were set up as a randomized complete block with each cultivar represented once in each block.

At the PSC, pollinator-friendly plants were an established as part of the landscape, and included *Vitex agnus-castes* L., *Rosa* x, *Rudbeckia hirta* L., *Rudbeckia maxima* Nutt., *Hibiscus moscheutos* L., *Hibiscus syriacus* L., *Pycnanthemum muticum* Michx., and many other flowering perennial and woody species. In spring 2020, a perennial bed was added adjacent to the CM beds. Species and cultivars added include *Buddleja* Buzz® 'Red Hot', *Echinacea* × *hybrida* 'Cheyenne Spirit', *Liatris spicata* (L.) Willd. 'Floristan Weiss', *Malvaviscus arboreus* var. *drummondii* (Torr. & A.Gray) Schery red and pink), *Monarda didyma* L. 'Balbalmac' (Balmy™ Lilac), *Nepeta racemosa* Lam. 'Walker's Low', *Salvia farinacea* Benth. cultivars 'Henry Duelberg', 'Augusta Duelberg', and 'SallyFun™ Deep Ocean', *Salvia greggii alba* Gray and 'Radio Red', and *Salvia guaranitica* A.St.-Hil. ex Benth. cultivars 'Amistad' and 'Black and Blue'.

At both sites, weeds were sprayed with glyphosate once monthly for weed control, and a mulch layer of 7.5 cm was maintained throughout the study. The surrounding grass and weeds were kept at 5 cm (2 in) to minimize non-experimental pollen sources.

Bee and pollinator monitoring. To assess overall bee numbers in the study area, two 30.5 m (100 ft) transects were created in native areas adjacent to, but outside of the CM gardens. As these transects were monitored, existing plants were identified, paying special attention to those foraged by honeybees. Each transect survey was conducted at a 7-minute pace, counting honeybees, other bees, and other pollinators.

To monitor CM bee visits, visual transect surveys were used, adapting a procedure from Riddle and Mizell (2016). Honeybee counts began the first week of July (or first bloom), and continued until trees averaged less than two clusters of open flowers per tree. Transect surveys were conducted weekly, and each tree was observed for 75 seconds (7 minutes per bed), observing the canopy from a single direction. Based on preliminary observations, honeybee activity in our area is highest around 10 am, so transects began at 9 am and continued until all transects had been completed.

Crepe myrtle flower monitoring. CM flower number and size were estimated by counting and sizing inflorescence clusters. As soon as flowering began, CM inflorescences per cluster and flowers per inflorescence were counted to create cluster standards. To develop these standards, only fully open flowers in anthesis were counted. The length and width of each cluster were measured and the average number of flowers per cluster determined. For each cultivar, we developed a standard that estimates the number of flowers per cluster, based on size, and placed clusters into one of three designations, large, medium, or small. Once weekly, a score was generated for each tree by counting the number of clusters in each category, and these were summed and used as a total number of flowers per tree. Flower counts stopped in late August, when all flowering had stopped.

Data analysis. Data were separated into two categories for analysis, 1) difference among cultivars, and 2) differences between locations. To address the first research question, the number of bee visits per cultivar were evaluated weekly to compare cultivars at CMRG. Data included number of honeybees per tree, estimated number of flowers per tree, and cultivar. Because larger flowering cultivars 'Natchez' and 'Tuscarora' were not present at both locations, bee counts from PSC were not included in this analysis.

To address the second research question concerning number of bee visits when in the presence of other potential foraging sites, the number of bee visits per plant were used to compare the two study sites. To maintain continuity in plant size, flower size, and bloom quantity, only 'Ebony Fire' at CMRG and 'Ebony Embers', 'Ebony Fire', 'Ebony Flame', and 'Ebony Glow' at PSC were evaluated when comparing locations. All of the Ebony crepe myrtles have a similar mature size and vary only in flower color. 'Ebony Embers', 'Ebony Fire', and 'Ebony Flame' have red flowers. 'Ebony Glow' has pink flowers. Data collected included number of honeybees per tree and estimated number of flowers per tree. Data from environmental transects is included as descriptive data for the environment.

On each set of data, a normality test was conducted using the UNIVARIATE procedure of SAS (ver. 9.4, SAS Inst., Cary, NC) as a check for normal distribution, and, if not, the appropriate distribution for analysis. All data were analyzed using the GLIMMIX procedure of SAS (version 9.4; SAS Institute, Cary, NC) with a Laplace approximation and a Newton-Raphson optimization. A negative binary distribution and a log link function was used for all score data (Stroup, 2015). Covariance structure was selected using the Akaike's information criterion (AIC) score. Means separation was conducted using Shaffer's simulated method ($\alpha = 0.05$).

Results and Discussion

At study initiation, 'Natchez' and 'Tuscarora' trees were between 2.5 and 3.5 m (8 to 12 ft) tall. 'Ebony Fire' plants were 1.5 to 1.8 m (5 to 6 ft) tall, and 'Pocomoke' were 1 m (3 ft) tall. An early freeze in October 2019 froze roughly 60% of CM specimens to the ground. Dead stems were removed, but plants regrew sufficiently in spring and early summer 2020 to regain most of the height lost. Regrowth did not affect bloom number, timing, or duration.

Bloom seasons were similar in 2019 and 2020, with blooms beginning in week 27 of 2019 and week 26 of 2020. Blooms persisted through week 34 in 2019 and week 35 in 2020. Though blooms were available for a longer period of time in 2020, honeybee numbers declined in our plots from 539 in 2019 to 130 in 2020 (Figs. 1 and 2). However, comparison of cultivars and location preferences were similar for both growing seasons. The early freeze that damaged CM could also have damaged local honeybee hives. Hive locations were not confirmed, but at least one hive was identified at the CMRG that was active in 2019 but was not in 2020. Also, June 2020 had a longer stretch of dry periods than 2019. June 2020 had zero precipitation until the 19^{th}, while June 2019 had precipitation dispersed throughout the month (Weather Underground 2020). For 2020, this likely negatively impacted native flowering plants used by bees during early summer foraging. Unfortunately, poor nutritional value and lack of available foraging resource can result in declining colonies (Di Pasquale et al. 2016), leading to a decline in local honeybees.

Honeybee visits by cultivar. In both 2019 and 2020, there were significant differences in honeybee visits among cultivars. 'Natchez' had more honeybee visits than any other cultivar, averaging 1.4 honeybee visits per tree using a 75 second count in 2019 and 1.2 in 2020 (Figs. 1 and 2). 'Tuscarora' had the second most honeybee visits, averaging 0.8 honeybees per tree per 75 second observation period in 2019 and 0.4 honeybees per tree per 75 second observation period in 2020. These two cultivars had the most blooms of the CM included in the study, with an average weekly bloom count in 2020 of 158.9 for 'Natchez' and 148.2 for 'Tuscarora'.

'Ebony Fire' and 'Pocomoke' had the fewest honeybee visits in both years, with 'Ebony Fire' averaging 0.2

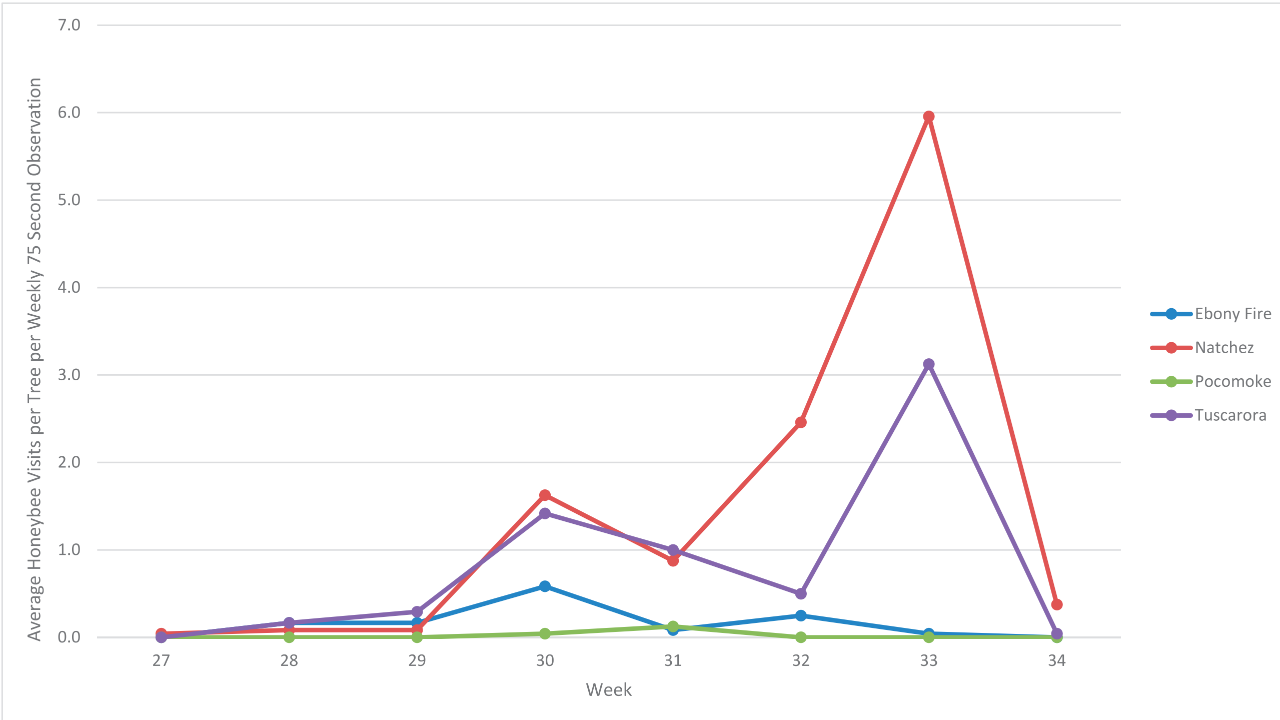

Fig. 1. Average number of honeybee visits per tree during 2019 for four crepe myrtle cultivars. Honeybees were counted using 75 second visual observations between 9:00 and 11:00 am on one day each week. Numbers represent averages across four blocks of six trees per block for each cultivar.

honeybee visits per tree per weekly 75 second observation period in both 2019 and 2020, and 'Pocomoke' averaging 0.03 and 0.02 honeybee visits per tree per weekly 75 second observation period in 2019 and 2020, respectively. In fact, 'Pocomoke' was rarely visited by honeybees, with only 4 honeybees observed during each of the 2019 and 2020 bloom seasons, including 0 honeybees observed in 8 of 10 weeks in 2020. 'Ebony Fire' and 'Pocomoke' had the

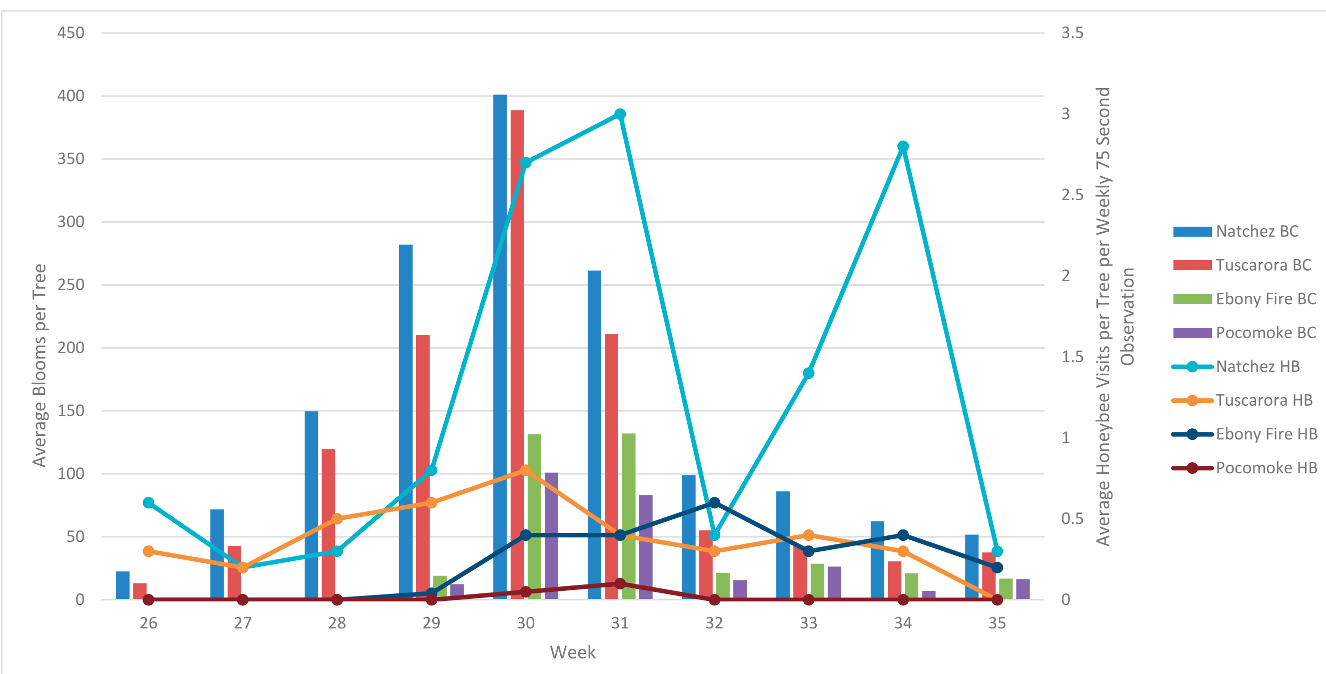

Fig. 2. Average number of blooms per tree and honeybee visits per tree during 2020 for eight crepe myrtle cultivars. Bloom numbers (BC) (represented by bars on the graph) were generated by developing a standard number of open blooms (blooms with visible pollen) per cluster and counting the number of small, medium, and large clusters per tree. Honeybees (HB) (represented by lines on the graph) were counted using 75 second visual observations between 9:00 and 11:00 am on one day each week. Numbers represent averages over a nine week period in summer 2020 across four blocks of six trees per block for each cultivar.

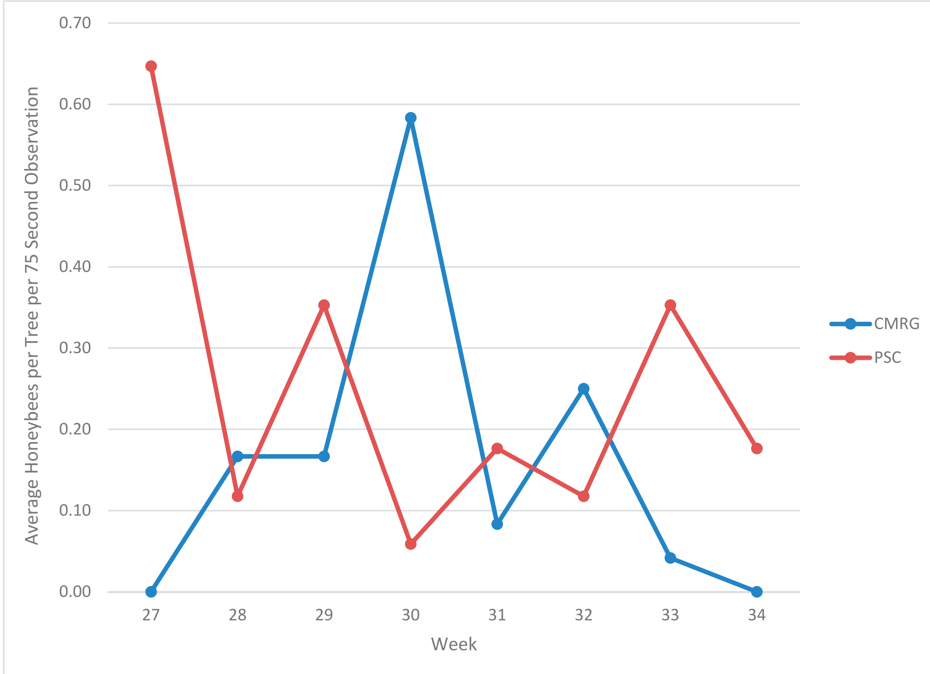

Fig. 3. Average number of honeybees per observation between two locations in 2019, the Texas A&M University-Commerce Crepe Myrtle Research Garden (CMRG) and the Texas A&M University-Commerce Plant Science Center (PSC). Honeybees were counted using 75 second visual observations between 9:00 and 11:00 am on one day each week.

fewest blooms of the CM included, with a weekly average bloom count of 35.6 and 35.7, respectively. To further decrease honeybee interest, 'Pocomoke' also has the smallest bloom, with an average bloom size of 2.0 to 2.5 cm (0.75 to 1 in) compared to 3.5 to 4.0 cm (1.4 to 1.6 in) in 'Natchez', 'Tuscarora', and 'Ebony Fire'.

Honeybee visits in 2019 to 'Natchez', 'Tuscarora', and 'Ebony Fire' had a small peak in week 30, averaging 1.6, 1.4, and 0.6 honeybee visits per tree, respectively, while the number of honeybee visits to 'Pocomoke' remained at zero (Fig. 1). 'Natchez' and 'Tuscarora' had a second influx of honeybee visits in week 34, with honeybee visits reaching 6.0 and 3.0 honeybees per tree, while 'Ebony Fire' and 'Pocomoke' counts reduced to 0 (Fig. 1). Because honeybee foraging declines in winds above 3.0 $m{\cdot}s^{-1}$ (Hennessy et al. 2020), this second influx was likely related to high winds in weeks 32 (6.7 $m{\cdot}s^{-1}$) and 33 (7.2 $m{\cdot}s^{-1}$) that limited honeybee foraging during the observation period and subsided in week 34. While bloom data was not collected in 2019, the foraging patterns of honeybees are consistent with those from 2020, and the differences between cultivars and 'Ebony Fire' is likely related to a decline in flowers during late summer, consistent with previous observations (Chretien and Harp 2017).

In 2020, 'Natchez' attracted more honeybees (3.0 honeybees per tree) than 2019 (1.6 honeybees per tree) during the same time period (week 30), corresponding with the highest bloom count of the year (401.1 blooms per tree) (Fig. 2). Honeybees seemed to favor 'Natchez', as it was visited most frequently in both 2019 and 2020 (Figs. 1 and 2). This can be explained by the larger quantity of blooms 'Natchez' in comparison to 'Tuscarora', 'Ebony Fire', and 'Pocomoke', per tree, respectively (Fig. 2).

Blooms and honeybee visits were significantly and moderately correlated ($P < 0.001$, $R = 0.51$), with the peak honeybee visits occurring with peak bloom in weeks 29, 30, and 31 (Fig. 1). Honeybee visits did not begin in earnest until blooms were well established and dropped off rapidly as bloom numbers decreased.

It is interesting to note that 'Pocomoke' was visited frequently by sweat bees (Halictidae), a bee that is much smaller than honeybees. Similarly, carpenter bees (Xylocopinae) were seen in 'Natchez', which has the largest bloom clusters of the CM tested.

Honeybee visits by location. Across both years of the study, location did not make a difference in terms of honeybee visits per tree. While other cultivars were present at each location, only Ebony series crepe myrtles were included in this comparison. In 2019, a total of 65 honeybees were observed on Ebony crepe myrtles at both locations during the study period, 31 at the CMRG and 34 at the PSC, an average of 0.16 and 0.25 honeybees per tree per weekly 75 second observation period, respectively (Fig. 3). In 2019, the highest number of honeybees [13 honeybees across 24 trees (an average of 0.65 honeybees per tree per 75 second observation period)] was recorded at the PSC during the first week of data collection (week 27), while trees at the CMRG had the most honeybee visits (0.58 honeybees per tree per 75 second observation period) in week 30 (Fig. 2). Weeks 27 and 30 were also the dates with the largest differences between locations (0.65 honeybees per tree per 75 second observation period and 0.52 honeybees per tree per 75 second observation period, respectively) (Fig. 3). Though bloom data was not collected in 2019, differences between locations on individual weeks was most likely related to available

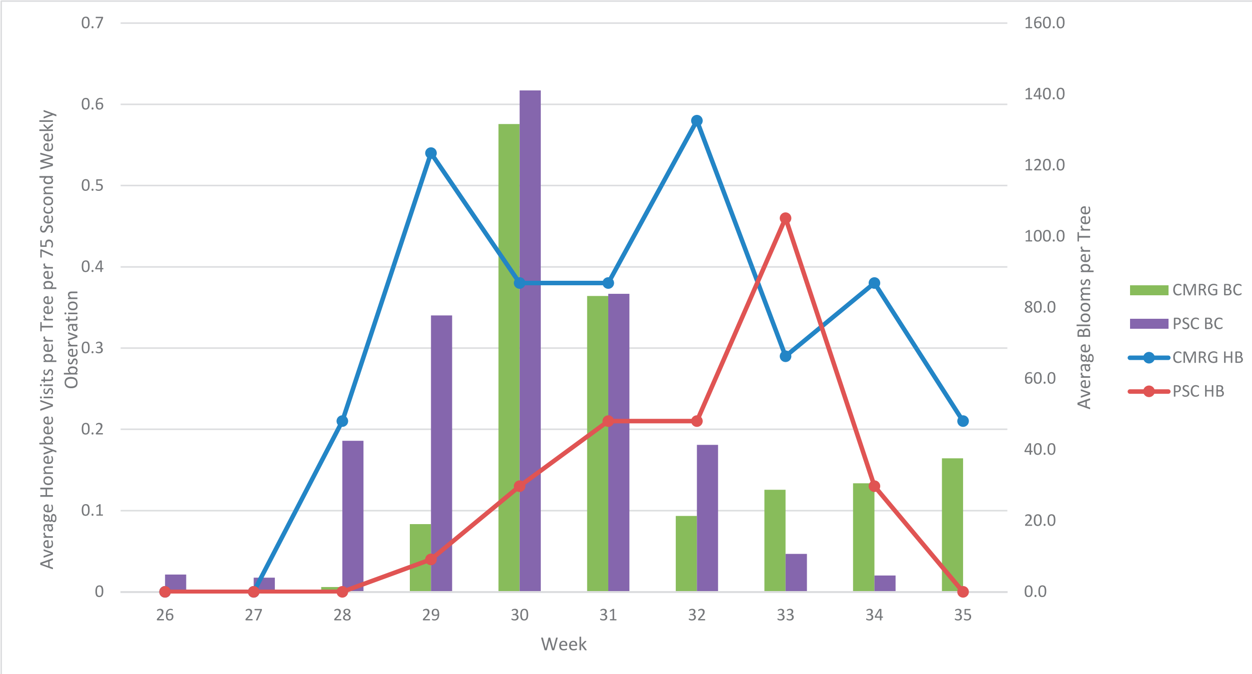

Fig. 4. Average number of blooms and honeybee visits between two locations in 2020, the Texas A&M University-Commerce Crepe Myrtle Research Garden (CMRG) and the Texas A&M University-Commerce Plant Science Center (PSC). Bloom numbers (BC) were generated by developing a standard number of open blooms (blooms with visible pollen) per cluster and counting the number of small, medium, and large clusters per tree. Honeybees (HB) were counted using 75 second visual observations between 9:00 and 11:00 am on one day each week.

blooms and the overall bloom pattern of 'Ebony Fire', which has a shorter bloom season than other cultivars tested (Chretien and Harp 2017).

Likewise, during the 2020 season, honeybee visits at the CMRG and the PSC did not differ. Total number of honeybees observed was 78 in 2020, with an average of 0.23 honeybees per tree per weekly 75 second observation period at the CMRG (54 total) and 0.16 honeybees per tree per weekly 75 second observation period (24 total) at the PSC (Fig. 4). The CMRG peaked at 0.58 honeybees per tree per 75 second observation period in week 32 and the PSC peaked at 0.46 honeybees per tree per 75 second observation period in week 33 (Fig. 4). The largest difference in honeybee visits (0.50 honeybees per tree per 75 second observation period) between locations occurred in week 34. Similar to observations among cultivars, there was a strong correlation between bloom number and honeybee visits in 2020.

Bee visits to crepe myrtle vs pollinator-friendly plants. In both 2019 and 2020, honeybees demonstrated a strong preference for CM, with an average of 15 honeybees observed per transect, ranging from 13.8 to 16.3, compared to 0.15 honeybees per 30.5 m (100 ft) plant transects (Table 2). While honeybee numbers declined in 2020, the preference for CM continued, with an average of 1.2 honeybees per tree transect, ranging from 1.1 to 1.4, compared to 0.1 honeybee per 30.5 m (100 ft) plant transects. Although CM does not produce nectar, honeybees forage willingly on crepe myrtle pollen (Lau et al. 2019, Riddle and Mizell 2016). The crepe myrtle pollen could provide nutritional values greater than what is supplied by other plants, and honeybees prioritize plant preference based upon known benefits (Haber et al. 2017).

Honeybee attraction to CM pollen may be attributed to its unique characteristics. Opening just before the anthers containing real pollen, feed pollen is similar in content but considerably different in composition (Table 1) (Nepi et al. 2003). Fructose is roughly 42% higher in feed pollen, giving it a similar composition to the nectar of pollinator-friendly plants (Table 1) (Kullali et al. 2011, Nepi et al. 2003). The pollen can also serve as a source of protein, lipids, vitamins, and minerals essential for colony health (Di Pasquale et al. 2016). In our study, the lack of

Table 1. Sugar composition of real pollen and feed pollen from crepe myrtle (*Lagerstroemia indica*) (from Nepi et al. 2003) and nectar from three species in the Lamiaceae (from Kulloli, S.K., A.N. Chandore, and M.M. Aitawade 2011. Nectar dynamics and pollination studies in three species of Lamiaceae. Current Sci. 100:509-516.).

Taxa	Total sugar (μg·mg^{-1})	Glucose (μg·mg^{-1})	Fructose (μg·mg^{-1})	Sucrose (μg·mg^{-1})	S/G+F
Lagerstroemia Real Pollen	86.0	21.3 ± 0.4	17.6 ± 1.5	47.1 ± 2.7	1.21
Lagerstroemia Feed Pollen	85.1	25.9 ± 0.1	38.9 ± 0.1	20.3 ± 1.2	0.31
Leonotis nepetifolia	100.1	45.4 ± 2.0	36.1 ± 1.6	18.6 ± 1.8	0.23
Leucas aspera	100.0	30.5 ± 1.7	15.6 ± 1.8	53.9 ± 1.6	1.17
Orthosiphon thymiflorus	107.8	58.2 ± 3.6	31.5 ± 1.8	18.1 ± 1.1	0.20

Table 2. **Average visits by honeybees and bumblebees among perennial transects and crepe myrtle transects[z]. Data collected in July and August 2019 and 2020 from plantings at the Texas A&M University-Commerce Plant Science Center (PSC).**

Transect[z]	Honeybee visits 2019[y]	Honeybee visits 2020	Bumblebee visits 2019	Bumblebee visits 2020
CM 1	13.4 a	1.1 ab	0.0 ns	0.0 b
CM 2	14.8 a	1.4 a	0.0 ns	0.2 b
CM 3	16.3 a	1.1 ab	0.0 ns	0.3 b
CM 4	15.3 a	1.2 a	0.0 ns	0.0 b
T 1	0.3 b	0.1 b	0.0 ns	12.4 a
T 2	0.0 b	0.1 b	0.1 ns	7.2 a

[z]Transects consisted of 30.5 m (100 ft) long linear distances consisting of either nearby landscape plants or six crepe myrtles. Insects were counted visually while walking at 7 min per 30.5 m (100 ft) or 75 seconds per crepe myrtle.

[y]Statistical analysis conducted using the GLIMMIX procedure (ver. 9.4, SAS Institute, Cary, NC), controlling for months as a repeated variable and means separated using Fisher's least significant difference with an α=0.05, means within columns followed by the same letter are not significantly different.

honeybees on nearby perennials and pollinator-friendly shrubs may be a combination of CM being a stable food source for bees and the propensity of honeybees to continue foraging a single source until it is depleted (Dimou and Thrasyvoulou 2012, Lau et al. 2019).

No bumblebees were observed in 2019, either in CM plantings or native plant stands. Adding the perennial planting in 2020 provided a forage source for bumblebees, with an average of 12.4 bumblebees observed each week. Bumblebees expanded their foraging to other plants at the PSC, and we observed an average of 7.2 bumblebees per week in PSC Transect 2. However, although some bumblebee species (*Bombus impatiens* Cresson and *Bombus fraternus* Smith) have been known to feed on CM (Riddle and Mizell 2016), the number of bumblebees observed in the CMRG transects foraging on CM remained at zero (Table 2).

Literature Cited

Bledsoe, M., C. Sutton, T. Bazhaw, M. Mendietta, and D.A. Harp. 2020. Mechanical control of crepe myrtle bark scale (*Acanthococcus lagerstroemiae* Kuwana). HortScience 55:S416 (Abstr.).

Bonmatin, J.M., C. Giorio, V. Girolami, D. Goulson, D.P. Kreutzweiser, C. Krupke, M. Liess, E. Long, M. Marzaro, E. A. D. Mitchell, D. A. Noome, N. Simon-Delso, and A. Tapparo. 2014. Environmental fate and exposure; neonicotinoids and fipronil. Environ. Sci. Pollution Res. 22:35–67.

Codling, G., Y.A. Naggar, J.P. Giesy, and A.J. Robertson. 2015. Concentrations of neonicotinoid insecticides in honey, pollen and honey bees (*Apis mellifera* L.) in central Saskatchewan, Canada. Chemosphere. 144:2121–2328.

Couvillon, M., K. Fensome, S. Quah, and R. Schurch. 2014. Summertime blues, August foraging leaves honeybees empty-handed. Community Integrative Biol. 71:e28821.

Di Pasquale, G., C. Alaux, Y. Le Conte, J.F. Odoux, M. Pioz, B.E. Vaissiere, L.P. Belzunces, and A. Decourtye. 2016. Variations in the availability of pollen resources affect honey bee health. PLoS ONE 11:e0162818.

Gu, M., M. Merchant, J. Robbins, and J. Hopkins. 2014. Crape Myrtle Bark Scale: A New Exotic Pest. Tex. A&M AgriLife Ext. Bul. EHT-049. 5 p.

Haber, A. I., J. W. Sims, M.C. Mescher, C.M. De Moraes, and D.E. Carr. 2017. A key floral scent component (β-trans-bergamotene) drives pollinator preferences independently of pollen rewards in seep monkeyflower. Functional Ecol. 33:218–228.

Hennessy, G., C. Harris, C. Eaton, P. Wright, E. Jackson, D. Goulson, and F.F.L.W. Ratnieks. 2020. Gone with the wind: effects of wind on honey bee visit rate and foraging behaviour. Animal Behaviour 161:23–31. https://doi.org/10.1016/j.anbehav.ac.uk.

Lau, P., V. Bryant, J.D. Ellis, Z.Y. Huang, J. Sullivan, D.R. Schmehl, A.R. Cabrera, and J. Rangel. 2019. Seasonal variation of pollen collected by honey bees (*Apis mellifera*) in developed areas across four regions in the United States. PLoS ONE 14:e0217294.

Leonhardt, S. and N. Bluthgen. 2012. The same but different: pollen foraging in honeybee and bumblebee colonies. Apidologie. 43:449–464.

Merchant, M.E., M. Gu, J. Robbins, E. Vafaie, N. Barr, A.D. Tripodi, A.L. Szalanski, and J. Hopkins. 2014. Discovery and spread of *Eriococcus lagerstromiae* (Hemiptera: Eriococcidae), a new invasive pest of crape myrtle, *(Lagerstroemia* spp.). https://bugwoodcloud.org/resource/pdf/ESAPosterDiscovAndSpread2014.pdf. Accessed 26 May 2021.

Nepi, M, M. Guarnieri, and E. Pacini. 2003. "Real" and feed pollen of *Lagerstroemia indica*: ecophysiological differences. Plant Biol. 5:311–314.

Riddle, C. T. and R.F. Mizell III. 2016. Use of Crape Myrtle, Lagerstroemia (Myrtales: Lythraceae), Cultivars as a Pollen Source by Native and Non-Native Bees (Hymenoptera: Apidae) in Quincy, Florida. Florida Entomol. 99:38–46.

Sanderson, C.E., B.S. Orozco, P.S.M. Hill, and H. Wells. 2006. Honeybee (*Apis mellifera ligustica*) response to differences in handling time, rewards, and flower colours. Ethology 112:937–946.

Waddington, K.D. and N. Gottlieb. 1990. Actual vs perceived profitability: a study of floral choice in honey bees. J. Insect Behavior 3:429–441.

Weather Underground. 2020. wunderground.com. Accessed 26 May, 2021.