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Investigating Producers' Preferences for Crapemyrtle and Their Perceptions Regarding Crapemyrtle Bark Scale

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Abstract: Crapemyrtle (*Lagerstroemia* spp.) is the most popular summer flowering tree in the U.S. Its total value sold has almost doubled since 1998. Consumers prize crapemyrtles for their beauty and being relatively pest free. However, current crapemyrtle production and use might be affected by crapemyrtle bark scale (CMBS; *Acanthococcus lagerstroemiae*), which has been confirmed in at least 14 U.S. states after its first sighting in Texas in 2004. In this study, we conducted interviews of business representatives. Our survey results indicate that producers anticipate a significant decrease in the value of crapemyrtle if infested with CMBS, and suggest industry demand for CMBS control. An important finding of our research is that a majority of businesses support science-based CMBS control research. Another important finding from our study is that most producers believed that benefits of CMBS control outweigh the costs. We used a relative importance index to illustrate the ranking of different attributes of crapemyrtles that producers consider while making decisions about growing/purchasing the plants. Flower color was found to be the most important attribute, followed by disease resistance. The most popular landscape plants that can potentially serve as alternatives to crapemyrtle, in the opinion of producers we surveyed, are *Vitex agnus-castus* (Texas lilac), *Magnolia* spp., and *Hibiscus* spp.

Keywords: crapemyrtle; *Lagerstroemia*; crapemyrtle bark scale; *Acanthococcus lagerstroemiae*; flowering tree; pest management; producer survey; relative importance index

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1. Introduction

Crapemyrtle (*Lagerstroemia* spp.) is the most popular flowering tree in the U.S. [1–3]. The total value of crapemyrtles sold has almost doubled since 1998, from approximately US $32.3 million in 1998 to almost US$67 million in 2014 (annual wholesale values) [1–3]. It is produced in 33 states, most of which are located in the southern part of the continental U.S., according to the 2014 USDA NASS Census of Horticultural Specialties [3,4]. The total number of crapemyrtles sold rose sharply by 152.6%, from approximately 1.9 million in 1998 to over 4.8 million in 2014 [1–3]. The reason why crapemyrtles are so popular in the U.S. is not only that they are relatively easy to grow, it is also because they offer a lot of variety with respect to color, plant size, growth habit, and their use [5]. Consumers prize crapemyrtles for their beauty, but they are also relatively free from pest issues [6].

Crapemyrtle bark scale (CMBS; *Acanthococcus lagerstroemiae* Borchsenius, 1960) is a novel pest affecting crapemyrtles in the U.S. [7]. Biologically, *A. lagerstroemiae* is sexually dimorphic [8]. For most of its lifetime, the adult female is sessile on the bark [8,9]. The insect secretes honeydew, which encourages sooty mold growth on the plants [8]. Not only does this limit the plants' photosynthesis, it also reduces their aesthetic value [8]. Additionally, if the infestation gets out of control, the sooty mold can coat the bark, which can be a huge concern for growers [7]. Crapemyrtle bark scale may result in sooty mold covering the bark, branch dieback, sparse flowering, and smaller flowers [10]. In some cases, it may also result in stunted growth, or even fatality of the plants [10]. Several characteristics of plants such as size, overall visual quality, and photosynthesis rate, are significantly affected due to CMBS infestation [11]. Crapemyrtle bark scale is native to East Asia and poses a serious threat to several plants such as persimmon, pomegranate, and crapemyrtles [10]. However, current crapemyrtle production and use is being threatened by CMBS [10]. It has been confirmed in at least 14 U.S. states (Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, Tennessee, Virginia, and Washington), after it was first sighted in north Texas in 2004 [10,12].

A few insecticides, particularly neonicotinoids, that control CMBS to some extent, pose a high risk to pollinators [13]. The Pest Management Strategic Plan for Container and Field-Produced Nursery Crops in FL, GA, KY, NC, SC, TN, and VA: Revision 2015, mentioned that there is no known biological control for CMBS [14]. Even though currently there are no reported instances of CMBS in California, the California Department of Food and Agriculture has given CMBS a rating of 14 in its pest-rating proposal, on a scale of 1 to 15 (the highest). Furthermore, it also mentions that CMBS can widely spread across California [15]. Even though it has a moderate host range, it has high reproduction as well as dispersal potential, due to which it can have an impact on the environment and cause economic repercussions in California [15].

Production of, and landscaping with, crapemyrtles is expected to continue since a majority of stakeholders of the green industry (e.g., growers, retailers, consumers, and landscape professionals) are unaware of the CMBS problem. This study aimed at investigating how CMBS affected landscape plant industry in general and the crapemyrtle growers in particular.

2. Materials and Methods

In this study, we conducted in-person interviews of business representatives at the Texas Nursery/Landscape EXPO in 2018 and 2019 (IRB Numbers: IRB2017-0754D). The survey participants were provided with a paper survey that they filled out themselves. The survey administrator was available to answer questions that the participants had. The participants were not provided any monetary compensation to take the survey. We have surveyed 32 and 47 businesses, in 2018 and 2019, respectively, from eight states—Alabama, California, Florida, Georgia, Louisiana, Mississippi, Tennessee, and Texas. Out of the 79 respondents, 75 were growers. The other four businesses included a wholesaler, re-wholesaler, nursery, and a broker.

Based on the responses in the surveys, we were able to divide the businesses into different categories based on several parameters such as their legal status, and the gross annual sales of the operation (Table 1).

Table 1. Classification of producers based on business types in the crapemyrtle survey sample.

Parameter	Categories (Number in Each)	Number of Businesses Surveyed
Legal status	Family or individual operation, and Partnership	26
	Incorporated under state law	37
	Others	3
	Declined to answer	13
Gross annual sales value of the operation	US$1,000,000 or more	50
	Under US$1,000,000	18
	Declined to answer	11
Gross annual value of crapemyrtle-related business for the operation	US$100,000 or more	29
	Under US$100,000	35
	Declined to answer	15

These surveys provided us with knowledge about the crapemyrtle production. The business representatives answered several questions regarding their knowledge of CMBS, their thoughts and concerns about CMBS, and details about their business and sales. The questions were presented using a Likert scale; the questions are listed in Table 2.

Table 2. Survey questions included in our interview of producers for CMBS study.

Survey Questions
Anticipate that CMBS will result in a significant drop in sales and use of crapemyrtles in your area.
Magnitude by which the price value for crapemyrtles will decrease if it is infested by CMBS.
Change in your willingness to grow crapemyrtles if it is infested by CMBS.
General opinion about developing systemic strategies to control CMBS.
Do you think that your operation will benefit from science-based CMBS control strategies?
Do you think the overall benefits from CMBS control will be higher than the cost of CMBS control?

We used the Kruskal–Wallis test (KW test) to compare the producers' responses to several questions among the different producer categories based on legal status, gross annual sales value of the operation, and gross annual crapemyrtle sales [16]. The KW test is a distribution-free nonparametric approach [17] to compare different groups based on a dependent variable measured by the ordinal level.

In the survey, we also asked the business representatives about the importance of different attributes of crapemyrtles when they are making decisions about growing/purchasing the plants. The relative importance index can be used to see the ranking of all the attributes based on their respective importance [18]. It has been commonly used in project management and engineering research (e.g., [19–23]). The relative index (RI) is calculated by the following formula [24]:

$$\text{RI} = \sum \frac{W}{A \times N} \tag{1}$$

Here, W is the "importance" assigned by the survey respondents, on a scale of one to four (1 = least important, 4 = highest in importance), A is the value for highest importance and N is the total number of respondents [19,24].

3. Results

3.1. Survey Responses

According to the producers we surveyed, the three cultivars with the greatest sales are Natchez, Muskogee, and Tuscarora. Additionally, the three most popular sizes for crapemyrtles are 15 gal, 30 gal, and 45 gal. These sizes refer to the volume of the containers in which the plants are potted. Our survey results, from both 2018 and 2019, indicate that producers anticipate a significant decrease in the value of crapemyrtle due to CMBS. Our surveys from 2018 showed that they anticipated a 29.93% decrease in the value of crapemyrtle due to CMBS; our surveys from 2019 showed that the producers anticipated a 33.79% decrease in the value of crapemyrtle due to CMBS. This is an alarming number, especially since crapemyrtle production is an important part of the horticulture industry.

Quite a number of the producers interviewed (72% and 61% in 2018 and 2019, respectively) also anticipated a decrease in the sale and use of crapemyrtles, in general, if the CMBS problem persists (Figure 1). Their willingness to grow crapemyrtle would also decrease if it were infested by CMBS. For example, 30% of the producers interviewed in 2018, and 43% of the producers interviewed in 2019 mentioned that their willingness to grow crapemyrtle would be significantly decreased if it were infested by CMBS. Another 30% and 23% of the producers in 2018 and 2019, respectively, mentioned that their willingness to grow crapemyrtle will be somewhat decreased if it were infested with CMBS (Figure 2).

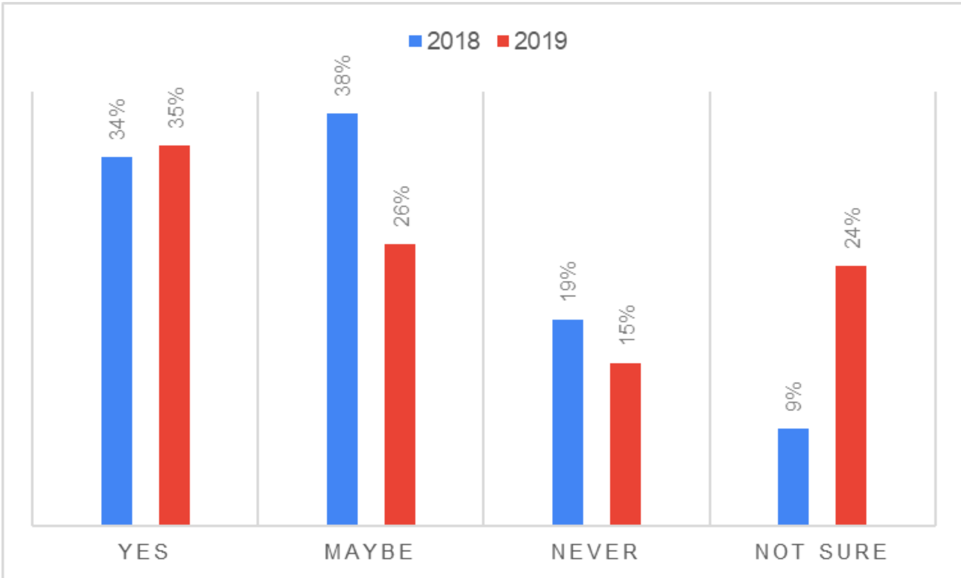

Figure 1. Producers anticipating a significant drop in sales and use of crapemyrtle if infested with CMBS (in %).

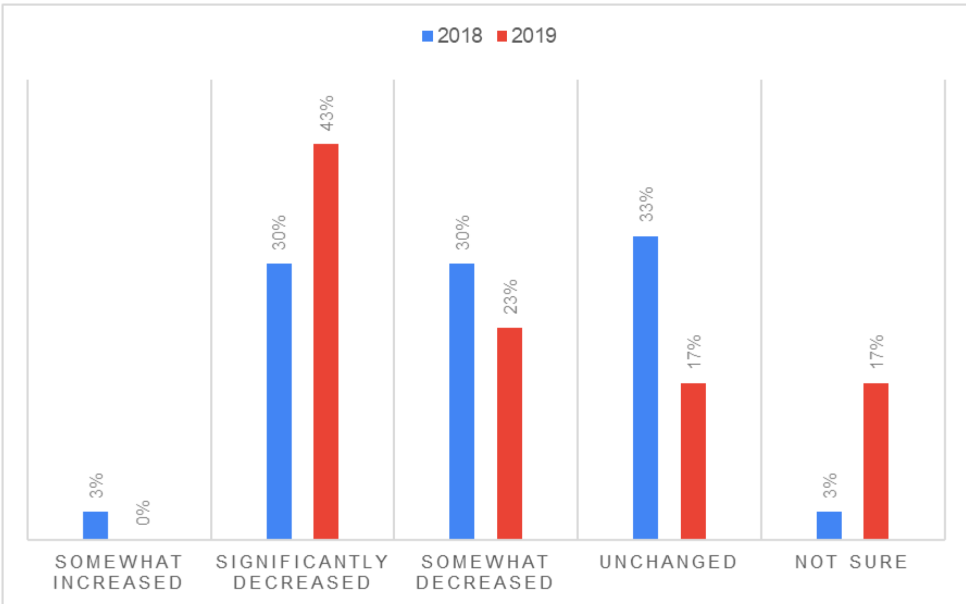

Figure 2. Decline in willingness to grow crapemyrtle if infested by CMBS (in %).

We also surveyed the business representatives about the most popular landscape plants that can potentially replace crapemyrtle. In the opinion of participants we surveyed, those were *Vitex agnus-castus* (Texas lilac), *Magnolia* spp., and *Hibiscus* spp.

The producers demonstrated support for systemic and scientific control strategies. Scientific control strategies include sustainable chemical control, the use of biological control agents, and other environmental-friendly methods, such as the development of insect-resistant cultivars [9,25–28]. A total of 69% of the producers interviewed in 2018, and 59% interviewed in 2019, strongly supported the development of systemic strategies for CMBS control (Figure 3). Another 9% and 15% of the producers interviewed in 2018 and 2019, respectively, were somewhat supportive of systemic strategies. Overall, 72% of the producers interviewed in 2018, and 55% interviewed in 2019, strongly supported science-based CMBS control (Figure 4). Another 16% and 30% of the producers interviewed in 2018 and 2019, respectively, were somewhat supportive of science-based CMBS control.

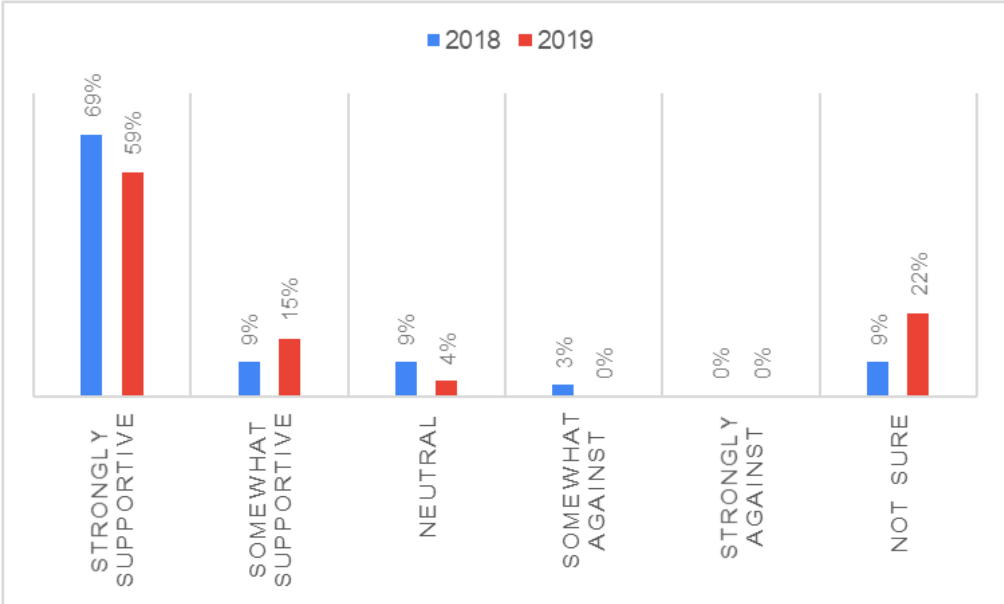

Figure 3. Producer support for development of systemic strategies for CMBS control (in %).

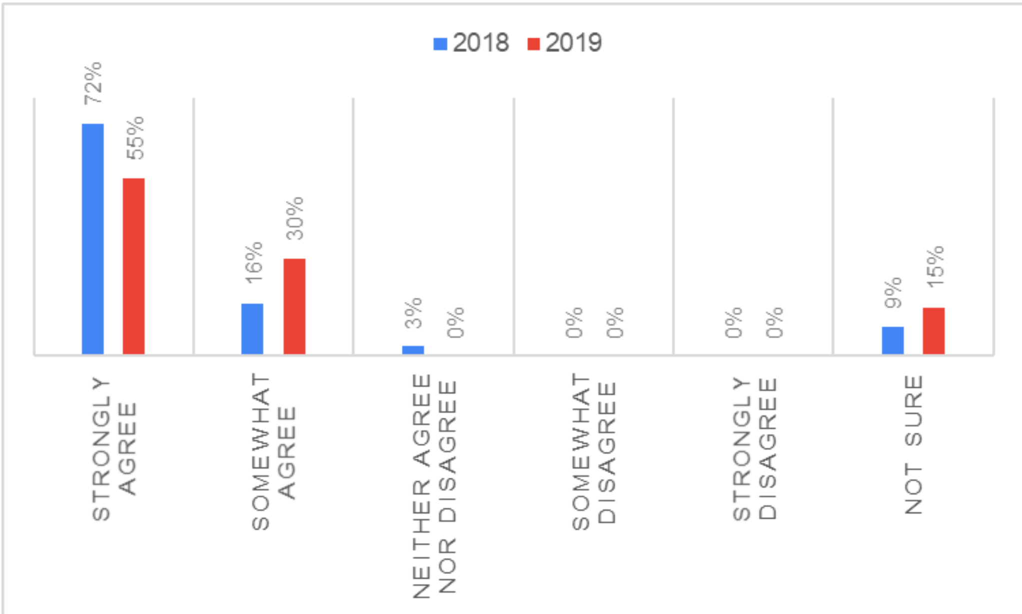

Figure 4. Producer support for science-based CMBS control research (in %).

3.2. Categorical Comparison by Business Types

There was a significant difference among different producer types based on gross annual sales (KW test $P = 0.081$), as well as crapemyrtle-related sales (KW test $P = 0.070$), regarding their thoughts on the magnitude by which the price value for crapemyrtles would decrease (in %) if it is infested by CMBS. Less than 6% of the representatives from businesses with under US$1,000,000 gross annual sales value thought that the value of crapemyrtles would fall by more than 60% if infested by CMBS, whereas 26% of the representatives from businesses with over US$1,000,000 gross annual sales value thought so (Figure 5). Also, 31% of the representatives from businesses with under US$100,000 gross annual crapemyrtle sales anticipated that the value of crapemyrtles would fall by over 60%, if infested by CMBS, whereas less than 7% of the representatives from businesses with more than US$100,000 gross annual crapemyrtle sales thought so (Figure 6). In conclusion, representatives of large businesses, and businesses with low volume of crapemyrtle-related sales predicted a more serious decrease in crapemyrtles' value if infested by CMBS as compared to others. There was no significant difference in the anticipated decrease in the price value of crapemyrtles if infested by CMBS, between business types based on legal status (Figure 7).

Figure 5. Magnitude of anticipated decrease in the price value for crapemyrtles (%) if infested by CMBS, by different producer types based on gross annual sale.

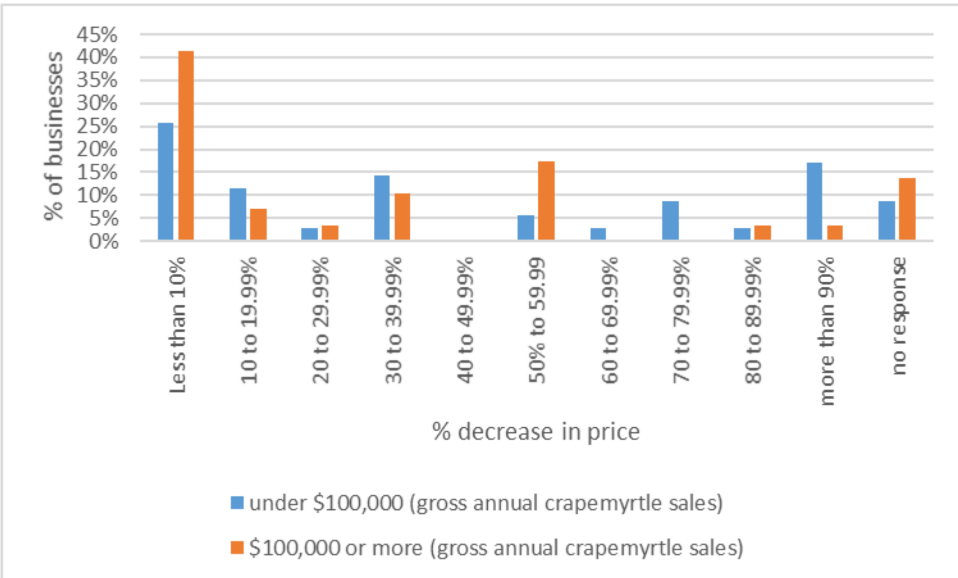

Figure 6. Magnitude of anticipated decrease in the price value for crapemyrtles (%) if infested by CMBS, by different producer types based on gross annual crapemyrtle-related sales.

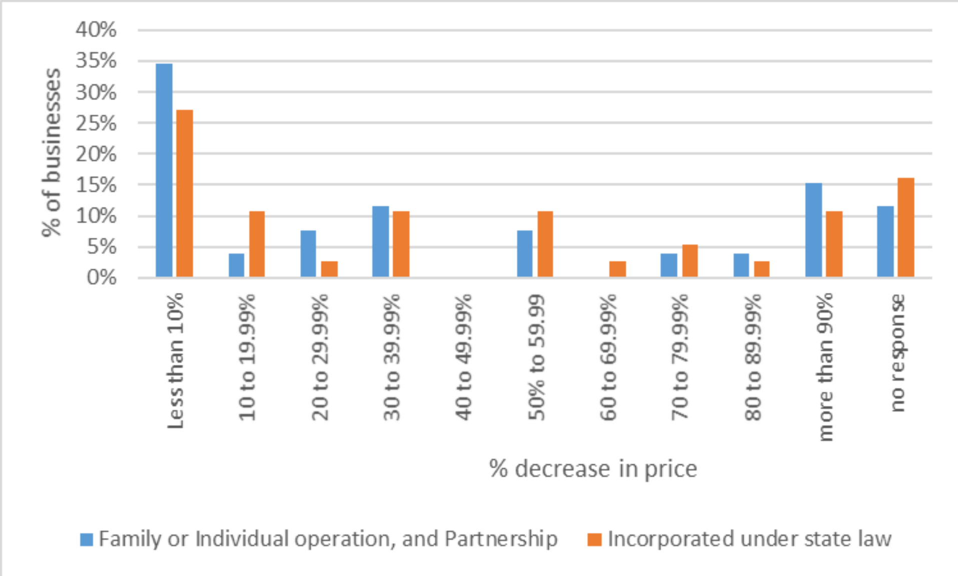

Figure 7. Magnitude of anticipated decrease in the price value for crapemyrtles (%) if infested by CMBS, by different producer types based on legal status.

In our analysis we also found that there was a significant difference about thoughts on whether the overall benefits from CMBS control will be higher than the cost of CMBS control, among business types based on gross annual value of crapemyrtle-related sales (KW test $P = 0.027$). On one hand, approximately 59% of representatives from businesses with over US$100,000 worth of crapemyrtle-related sales agreed that overall benefits from CMBS control would be higher than its cost; less than 4% disagreed with that statement. On the other hand, 49% of the representatives from businesses with under US$100,000 worth of crapemyrtle-related sales agreed, and 15% disagreed with that statement (Figure 8). In summary, more business representatives with high volume of crapemyrtle-related sales considered the benefits of CMBS-control to be higher than its cost, as compared to others.

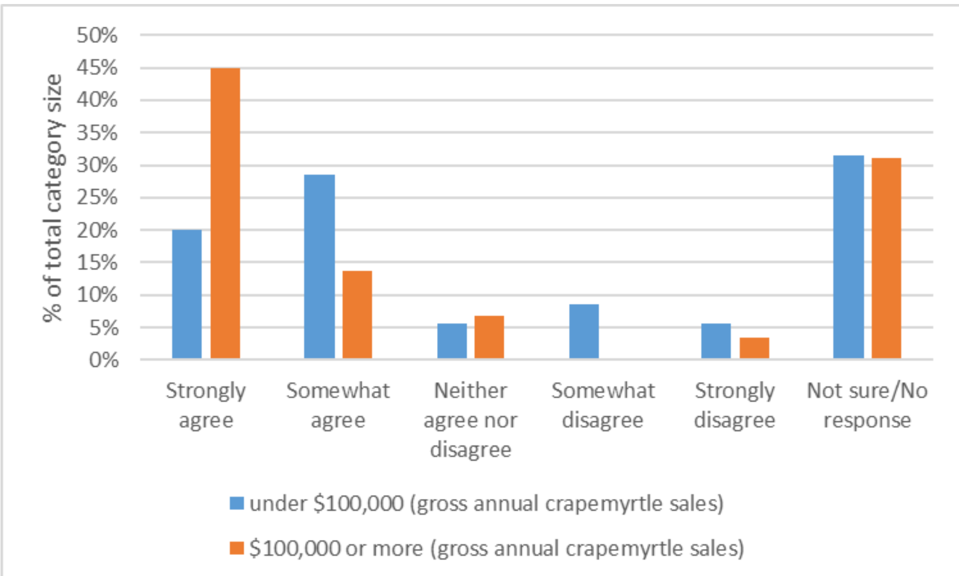

Figure 8. Overall benefits from CMBS control higher than its cost by different producer types based on gross annual crapemyrtle-related sales.

There was no significant difference regarding opinion on benefits of CMBS control outweighing its cost, between business types based on gross overall sales, as well as legal status. Approximately 65% of representatives for family or individual operations, and partnerships, agreed that overall benefits from CMBS control would be higher than its cost; less than 8% disagreed with that statement. Of the representatives for incorporated businesses, 43% agreed, and less than 11% disagreed with that statement (Figure 9). Similarly, 56% of representatives from business with over US$1,000,000 worth of gross annual sales value agreed, and 6% disagreed with that statement; 44% of the business representatives with under US$1,000,000 worth of gross annual sales value agreed, and less than 17% disagreed with that statement (Figure 10).

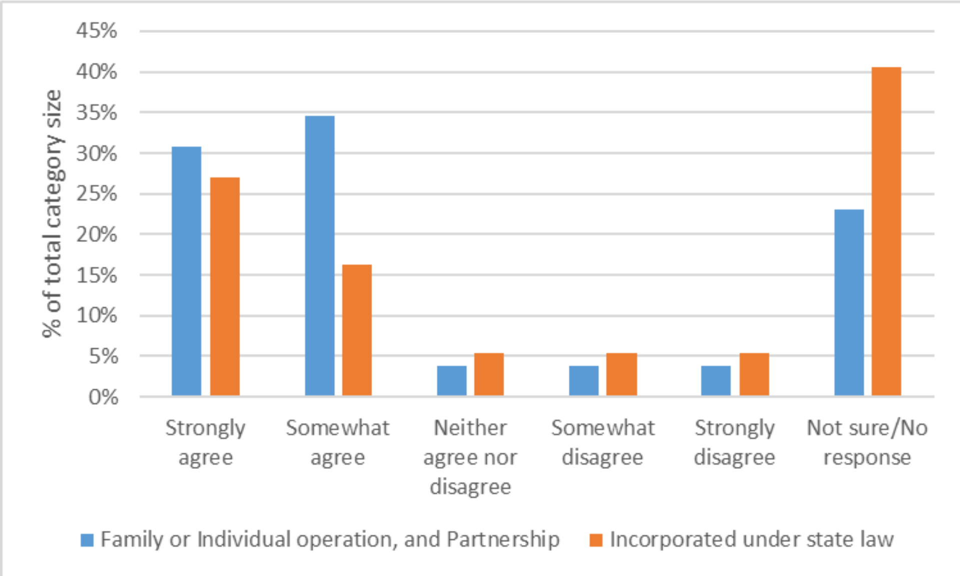

Figure 9. Overall benefits from CMBS control higher than its cost by different producer types based on legal status.

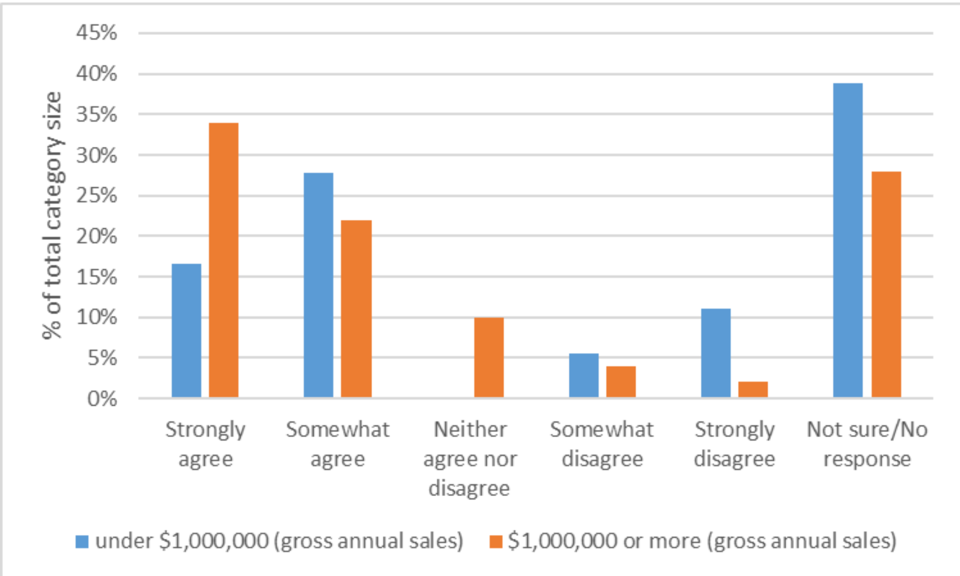

Figure 10. Overall benefits from CMBS control higher than its cost by different producer types based on gross annual sale.

Finally, there was a difference in support for science-based control strategies between business types (KW test $P = 0.064$). Of representatives for family or individual operation, and partnerships, 81% agreed that their operation would benefit from science-based CMBS control strategies; 89% of the representatives for incorporated businesses agreed with the statement. In summary, representatives of incorporated businesses showed more support, as compared to partnerships and family/individual operations, for science-based CMBS control research. These findings suggest an immediate need for CMBS control. Our surveys indicated that overall, most producers believed that benefits of CMBS control were higher than the costs (Figure 11). This implies that there is industry demand for CMBS control.

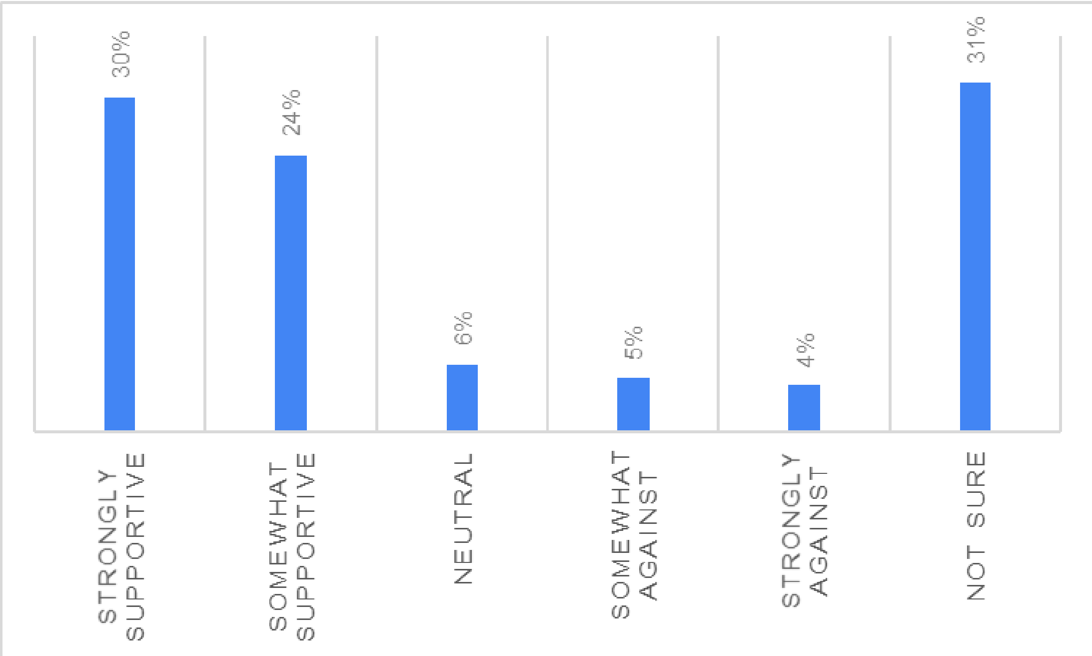

Figure 11. Crapemyrtle bark scale control: benefits higher than cost (in %).

3.3. Relative Importance Index

Business representatives ranked the importance of different attributes of crapemyrtles that they consider when they are making decisions about growing/purchasing the plants (Figure 12). The relative importance indices for different attributes are shown in Table 3. Flower color was found to be the most important attribute. This result is intuitive since the producers would choose what colors to grow based on the consumers' demand in the previous years. Flower color was followed by disease resistance. This is an important finding. It implies that once the producer makes the decision regarding which color crapemyrtle to grow, the next attribute that holds the highest importance is disease resistance. This suggests how important CMBS control is for producers. We used the KW test to compare the rankings between the two years included in our sample [16]. There was no significant difference in the relative importance of attributes between 2018 and 2019. The relative index (RI) can be used to assign the importance levels to the attributes. There are five levels corresponding to the relative index values: a. $0.8 \leq RI \leq 1$: high (H), b. $0.6 \leq RI \leq 0.8$: high-medium (H–M), c. $0.4 \leq RI \leq 0.6$: medium (M), d. $0.2 \leq RI \leq 0.4$: medium-low (M–L), and e. $0 \leq RI \leq 0.2$: low (L) [29]. In addition to a comparative analysis, this importance level helps in identifying the individual importance of each attribute (Table 3). In our analysis, flower color, disease resistance, height, and growth habit were determined to be of "High" importance level. In addition, easy maintenance, foliage color, and bark color were determined to be of "High-Medium" importance level. This suggests that all of the attributes are extremely important while making purchasing/growing decisions.

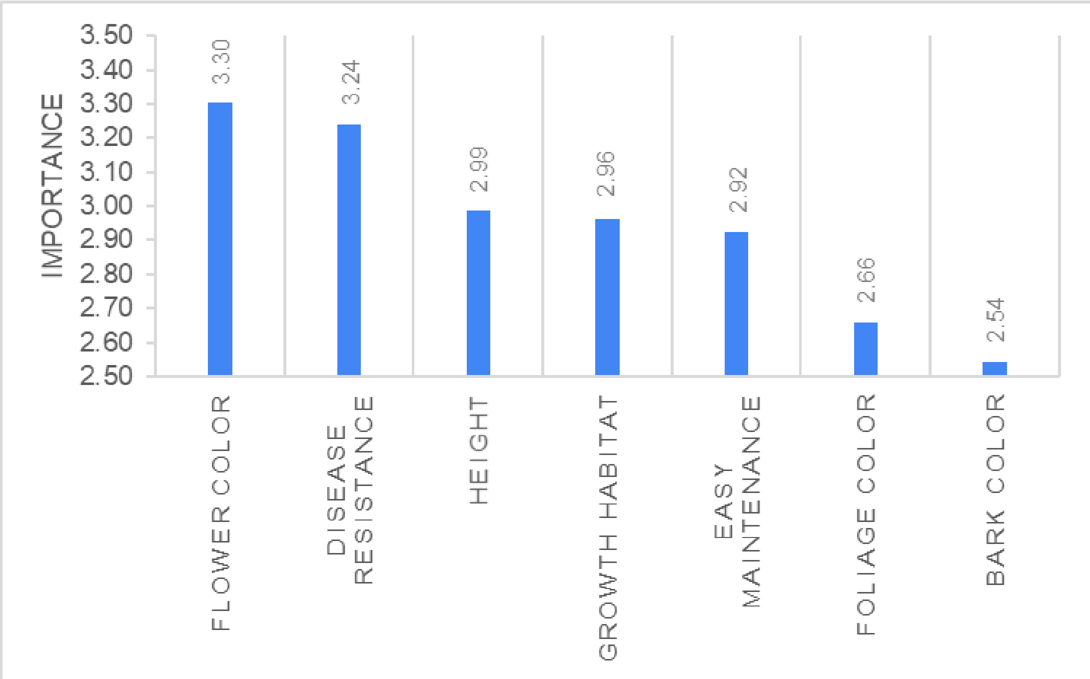

Figure 12. Importance of different attributes (on a scale of 0 to 4).

Table 3. Relative Importance Index (RII) of plant attributes for producers when making crapemyrtle purchasing decisions.

Attribute	2018	2019	Overall		
	RII	RII	Mean RII	Rank	Importance Level
Flower color	0.90	0.91	0.91	1	High
Disease resistance	0.85	0.87	0.86	2	High
Height	0.84	0.82	0.83	3	High
Growth habit	0.82	0.81	0.81	4	High
Easy maintenance	0.76	0.80	0.78	5	High-Medium
Foliage color	0.75	0.75	0.75	6	High-Medium
Bark color	0.69	0.72	0.70	7	High-Medium

4. Discussion

Previous research has looked into the causal organism and mechanism of CMBS [7–9]. Extant literature also provides some insights into ways to manage CMBS—physical cleaning, systemic strategies, and scientific control strategies [6]. While previous research can be used to control CMBS, there is an immediate need to analyze the economic impact of this pest. Managing CMBS is associated with various economic costs. This includes loss of commercially important attributes such as sooty black bark color and reduced flower density; it also includes the financial costs associated with the control of CMBS as well as the time and resources spent on researching more effective control strategies. Since crapemyrtle has enjoyed increased popularity over time, is produced in almost two-third of the states, and is a US$67 million industry, it is imperative to counter these economic impacts of CMBS. If the issue of CMBS gets out of control, it might have two serious implications. First, it could result in a decrease in the demand for crapemyrtles [3]. Second, the horticulture industry would need to find potential replacements to crapemyrtle. In essence, it may induce a shift in the demand of different products within the horticulture industry. Both of these shifts can potentially have a huge impact on businesses. Our findings indicate industry demand for CMBS control, and show that producers anticipated a decrease in crapemyrtle value and sales, if infested with CMBS.

It is important to note here that our analysis results indirectly from the subjective opinions of business owners based on our survey. Further analysis into direct economic indicators can be carried out as part of future research. Crapemyrtle bark scale can be controlled using a variety of methods, including physical cleaning/washing of plants [6]. Systemic strategies are also useful for its control, and in fact shown the most promise in experiments [6]. Soil-applied neonicotinoids were found to suppress CMBS to a significant extent [6]. An important finding of our research is that a majority of business representatives support science-based CMBS control research. In addition, more business representatives with high volume of crapemyrtle-related sales considered the benefits of CMBS control to be higher than its cost, as compared to other businesses. These findings usher in optimism for researchers working on CMBS control, and it would motivate more projects researching control strategies. It is therefore important to create effective communication and information material regarding CMBS and its control, tailored to different business types—growers, wholesalers, retailers, and landscapers.

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Institutional Review Board Statement: The study was approved by the Institutional Review Board of Texas A&M University (protocol code IRB2017-0754D and date of approval 10/23/2017).

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Conflicts of Interest: The authors declare no conflict of interest.

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