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Paclobutrazol Effects on Growth Performance and Public Preference on Potted *Syzygium myrtifolium* (Roxb.) Walp.

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ABSTRACT

A study was conducted to investigate the effects of plant growth retardant, Paclobutrazol (PBZ) on the growth performance and public preference on the treated-*Syzygium myrtifolium* (Roxb.) Walp. for container planting. In landscape, *S. myrtifolium* is always planted as a hedge plant, single planting or topiary for roadsides, urban parks, house lawns and golf clubs. However, it requires frequent trimming to maintain the aesthetic functions as it grows vigorously. PBZ was thought to be a better technique to reduce trimming activity and at the same time able to maintain crown form. *S. myrtifolium* plants were planted in polyethylene bags (33 cm x 27 cm) filled with soil, organic matter and sand (3:2:1). PBZ at rates of 0, 1.25, 2.50 and 3.75 g/L were soil drenched at 30 days after the plants were trimmed at approximately 100 cm in height and new shoots were produced. Growth performance (plant height, leaf area and leaf area index) of *S. myrtifolium* were observed monthly, while public preference on the appearance, aesthetic value and willingness to purchase *S. myrtifolium* were obtained by using a questionnaire form. Fifty individuals of various occupations related to the landscape industry were randomly chosen from 140 participants of a series of landscape courses conducted by the Forest Research Institute Malaysia (FRIM) over a period of five years. PBZ significantly reduced plant height and leaf area, however the leaf area index increased. No significant difference in terms of growth performance of *S. myrtifolium* was observed among different rates of PBZ. Enhanced appearance and aesthetic value of *S. myrtifolium* were also indicated by the respondents. Application of PBZ greatly increased the market value of *S. myrtifolium* for container planting purposes.

Keywords: Aesthetic value, container planting, growth inhibition, landscape maintenance, leaf area index, plant growth retardant, willingness to purchase

ABSTRAK

Satu kajian telah dijalankan untuk mengenalpasti kesan perencat pertumbuhan pokok, Paklobutrazol (PBZ) terhadap tumbesaran, nilai estatik dan kesanggupan membeli pokok *Syzygium myrtifolium* (Roxb.) Walp. yang ditanam untuk tujuan pasuan. Di dalam landskap, *S. myrtifolium* sering ditanam sebagai pokok pagaran, pokok teduhan atau topiari untuk pinggiran jalan, taman bandaran, halaman rumah dan kelab golf. Walau bagaimanapun, pokok ini memerlukan pemangkasan yang kerap untuk mengekalkan fungsi estatik kerana pertumbuhannya yang cepat. PBZ mungkin merupakan teknik yang lebih baik bagi mengurangkan aktiviti pemangkasan, dan dalam masa yang sama mampu mengawal bentuk silara pokok. Pokok *S. myrtifolium* ditanam di dalam beg politena (33 cm x 27 cm) yang diisi dengan tanah, bahan organik dan pasir (3:2:1). PBZ dengan kadar 0, 1.25, 2.50 and 3.75 g/L disiram ke atas media penanaman selepas 30 hari pokok dipangkas lebih kurang 100 cm tinggi serta mengeluarkan daun baru. Tumbesaran pokok (tinggi pokok, luas daun dan indeks luas daun) *S. myrtifolium* direkodkan setiap bulan, manakala pendapat umum terhadap rupa, nilai estatik dan kesanggupan membeli *S. myrtifolium* dikumpul menggunakan borang soal selidik. Seramai 50 individu dari pelbagai bidang pekerjaan yang berkaitan dengan industri landskap dipilih secara rawak daripada 140 peserta kursus landskap yang telah dianjurkan oleh Institut Penyelidikan Perhutanan Malaysia (FRIM) dalam tempoh lima tahun yang lalu. PBZ didapati mengurangkan tinggi pokok dan luas daun, tetapi meningkatkan indek luas daun. Tiada perbezaan prestasi pertumbuhan *S. myrtifolium* yang signifikan di antara kadar PBZ yang berbeza. Responden juga berpendapat rupa dan nilai estatik *S. myrtifolium* meningkat selepas rawatan PBZ. Aplikasi PBZ telah meningkatkan nilai pasaran pokok *S. myrtifolium* untuk tujuan pasuan.

Kata kunci: Nilai kecantikan, tanaman pasuan, perencatan pertumbuhan, penyelenggaraan landskap, indeks luas daun, perencat pertumbuhan pokok, kesanggupan membeli

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INTRODUCTION

Syzygium myrtifolium (Roxb.) Walp., locally known as *Kelat Paya,* belongs to the family of Myrtaceae. This species is categorized as a medium sized tree, reaching 8 m in height in its natural habitat and usually shorter in cultivation areas. It is found by the coastal regions of the Peninsular Malaysia especially in Terengganu, Kelantan, Pahang and Johor (Anonymous, 2001). It has a conical crown shape

during its young stage and it becomes rounded when mature. This species is always chosen for urban beautification purposes because it is a hardy species, easy to grow, resistant to pest and diseases, and dynamic in terms of landscape functions. Due to its reddish young foliage and dense branching, *S. myrtifolium* is widely planted as a hedge plant, topiary or shade tree in the urban landscapes. However, this species grows vigorously and it requires frequent trimming to maintain the aesthetic functions.

Plant growth retardant, *i.e.* paclobutrazol (PBZ), [(2RS, 3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1H-1,2,4-triazol-1-yl) pentan-3-ol] is widely used to control plant growth. The most obvious plant growth response to this triazole treatment was reduced stem elongation and hence reduced plant height (Kamountsis and Chronopoulu-Sereli, 1999; Starman and Williams, 2000; Schoellhorn, 2001; Sharma *et al.,* 2009; Ahmad Nazarudin, 2012). Main stem height suppression was associated with shorter internode elongation and not to a decrease in node number (Pinto *et al.,* 2005; Taiz and Zeiger, 2006). The optimum dosage of PBZ required in controlling the vegetative growth may differ among plant species and it depends on environmental or growing conditions. Other effects of PBZ on plant growth were reduction in leaf area (LA) as reported on *Dianthus caryophyllus* (Sebastian *et al.*, 2002) and *Mangifera indica* (Yeshitela *et al.,* 2004).

PBZ was also reported to effectively improve the aesthetic values of numerous ornamental shrubs and herbs by producing plants with compact crown but with an increase in the number of flowers. Some positive results were observed in *Bougainvillea glabra* (Karaguzel and Ortacesme 2002), *Zinnia elegans* (Pinto *et al.,* 2005), *Calendula officinalis* (Mahgoub *et al.,* 2006), *Dendrobium* orchids (Te-chato *et al.,* 2009), *Consolida orientalis* (Mansuroglu *et al.,* 2009) and *Hibiscus rosa-sinensis* (Ahmad Nazarudin, 2012).

This study was designed to investigate the effects of PBZ on the growth performance, *i.e.* plant height, LA and leaf area index (LAI) of *S. myrtifolium* in container planting under local conditions. It was also attempted to assess the public preference on the appearance, aesthetic value and willingness to purchase (WTP) of *S. myrtifolium* after treatment with PBZ as a means for controlling growth.

MATERIALS AND METHODS

Study Site

This study was conducted at the nursery of the Forest Research Institute Malaysia (FRIM), Kepong, Selangor, Malaysia (3°10'0" N/101°42'0" E). During the study period, the mean daily temperature ranged from 21.1 to 34.2 °C and the annual rainfall was 1914.8 mm.

Plant Materials and Treatments

The seedlings of *Syzygium myrtifolium* were obtained from a local nursery in Sungai Buloh, Selangor. They were planted in polyethylene bags (33 × 27 cm), filled with a mixture of topsoil, organic matter and sand at a ratio of 3:2:1 by volume. The plants were grown under full sunlight and used for the experiment one year after planting in the polyethylene bags. The plants were first trimmed to columnar shape with an approximate height of 100 cm and allowed to produce new shoots prior to PBZ application. Young foliage of *S. myrtifolium* was fully emerged after 30 days following the trimming.

Cultar-250 formulation, 250 g a.i. (active ingredient) PBZ per litre, was tested in this study. Each rate of PBZ (0, 1.25, 2.50 and 3.75 g/L) was topped up to 1 L volume with tap water before being applied to the planting medium. 1 L of tap water was then applied to the control plants. RCBD was assigned for the experiment with ten replicates. A total of 40 plants were used in this study. The plants were watered twice daily, *i.e.* in the morning and evening, or when necessary depending on the weather. Monthly, Nitrophoska Green (15:15:15) was applied at a rate of 5 g per plant to ensure satisfactory plant growth.

Data Collection

Plant height (cm) measurement was taken from the soil surface in the polyethylene bag to the highest shoot tip by using a telescopic height stick. The first three fully developed leaves from each plant were measured for LA (cm^2) by using a leaf area meter (Li-3100 Nebraska, USA). For the LAI, Plant Canopy Analyzer, (LAI 2000 Nebraska, USA) was used. One measurement was recorded outside the plant canopy and three measurements were recorded under the plant canopy for each LAI calculation. LAI is broadly defined as the amount of leaf area (m^2) in a canopy per unit ground area (m^2) (Asner *et al.,* 2003). Plant height, LA and LAI data were collected monthly (January 2006 to June 2006).

To facilitate this study, a questionnaire form with photographic attachment (Fig. 1) was designed and distributed to the respondents after eight months of treatment. A total of 140 participants from a series of landscape courses organized by the FRIM over a five year period were listed. Each individual within the population was assigned a number and then each third individual was selected for inclusion in the study. Fifty individuals were finally chosen, representing 35.7% of the participants.

Statistical Analysis

Plant height, LA and LAI data was subjected to ANOVA and treatment means were compared using Turkey's Honestly Significant Difference (HSD) test ($p<0.05$) to detect significant difference between treatments.

Descriptive analysis was carried out by using the Statistical Package for Social Science (SPSS) to obtain the frequency and percentage of the public preference variables. The information needed included the preference for *S. myrtifolium* after treatment with PBZ in terms of plant appearances and aesthetic value, WTP the treated *S. myrtifolium,* and the price offered by the respondents for the treated *S. myrtifolium.*

Fig. 1. Uncontrolled growth of the untreated plant (left), and inhibited growth of PBZ-treated plants (right) of *Syzygium myrtifolium.* Photographs were taken at eight months after the treatment.

RESULTS AND DISCUSSION

Growth Performance

Figure 2 shows the height increment of *Syzygium myrtifolium* after treatment with PBZ. Differences in plant height were recorded among the treated plants and the control plant at the first month after the application of PBZ. However, there was no variation in plant height among the treated plants. At the fifth month, the control plant had grown drastically (125.5 cm), as compared to the plant treated

with 3.75 g/L PBZ (100.2 cm), showing a reduction of 20.2%. The growth of the control plants was uncontrolled, until it affected its crown shape and needed to be trimmed in order to restore its previous columnar form. These results suggested that PBZ successfully inhibited the vegetative growth and at the same time reduced the trimming requirement of the species. In addition, PBZ effectively reduced shoot elongation of other ornamental plants such as *Swainsona formosa* (Hamid and Williams, 1997), *Ficus microcarpa* (Ahmad Nazarudin *et al.*, 2003), *Nerium oleander* (Ochoa *et al.,* 2009) and *Camellia japonica* (Larcher *et al.,* 2011). Biochemically, PBZ inhibited growth promoting phytohormone (GAs) biosynthesis, reducing cell elongation and retarding the plant growth (Sponsel, 1995; Kamountsis and Chronopoulu-Sereli, 1999; Fletcher *et al.,* 2000).

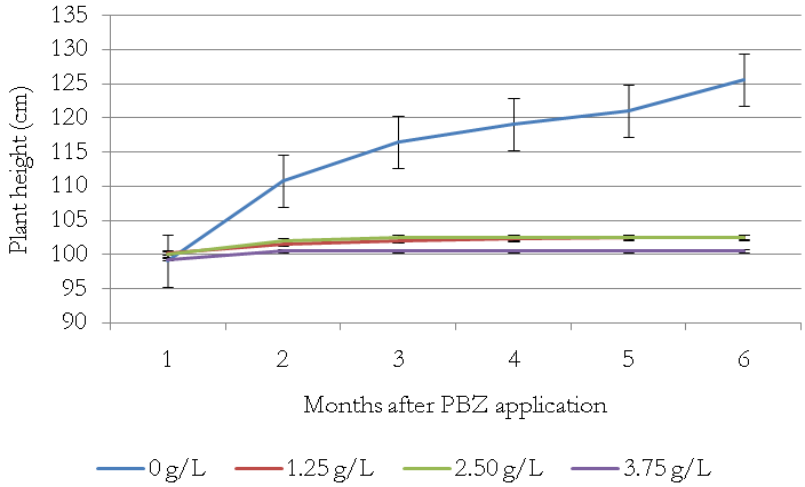

Fig. 2. Effects of PBZ on the plant height of *Syzygium myrtifolium*. Error bars shown are standard errors of means.

Syzygium myrtifolium produced young leaves within one to two months depending on weather. However, continuous flushing occurred during the wet season. Inhibition effect of PBZ was observed on the leaf expansion of *S. myrtifolium* (Fig. 3). The treated plant has smaller leaf size as compared to the control plants. Before 3.75 g/L PBZ was applied, the plant had about 11.02 cm^2 of LA, and it was recorded at 7.87 cm^2 after one month of the application, showing a reduction of 28.6%. After five months of application, 3.75 g/L PBZ reduced the LA to about 4.47 cm^2, while the control plants had a bigger LA of 11.17 cm^2, showing 59.98% reduction. However, there was no significant difference in LA among the treated plants in this study. Visually, there was no curly or abnormal leaves observed after the PBZ treatments on this species. Similar results were also reported on *Feijoa sellowiana* and *Ligustrum japonicum* (Martin *et al.,* 1994), and *F. microcarpa* (Ahmad Nazarudin *et al.*, 2003) following the PBZ treatment.

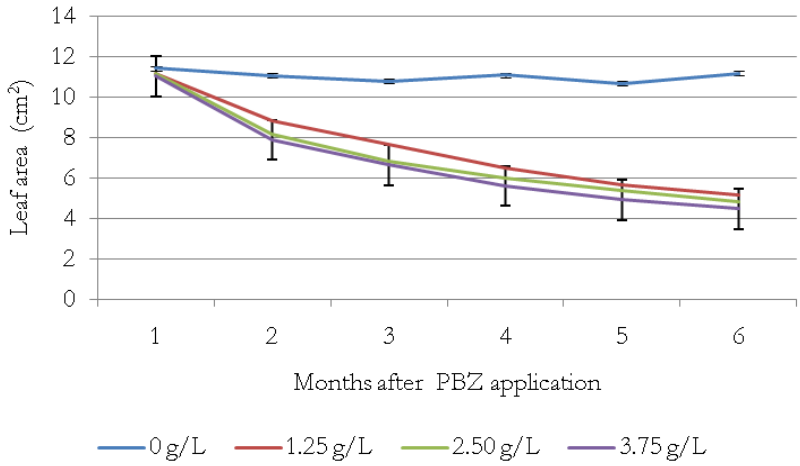

Fig. 3. Effects of PBZ on the LA of *Syzygium myrtifolium*. Error bars shown are standard errors of means. Error bars for 1.25 g/L and 2.50 g/L PBZ were omitted for clarity.

For the first four months after the PBZ treatment, there was no significant difference in terms of LAI (Fig. 4). The LAI of the treated plants increased, however for the control plant, it dramatically dropped from three months onwards. Nevertheless, after the fifth month of treatment, LAI of the control plant was reduced by about 15.1%, while those of the plants treated with 1.25 g/L, 2.50 g/L and 3.75 g/L were improved by 27.2%, 35% and 35.3%, respectively. PBZ at 2.50 g/L and 3.75 g/L gave higher LAI as compared to the control. However, no differences in LAI were found among the PBZ-treated plants. PBZ-treated plants had shorter internodes as compared to the control plants, resulting in a more compact arrangement of the branching system. Higher LAI in the treated plants demonstrated the enhancement of the crown compactness. On the other hand, lower LAI in the control plant expressed an irregular crown shape with uncontrolled lateral growth, resulting in greater land coverage of the crown due to vigorous growth of the plant. These results suggest that PBZ enhanced the crown compactness of *S. myrtifolium*.

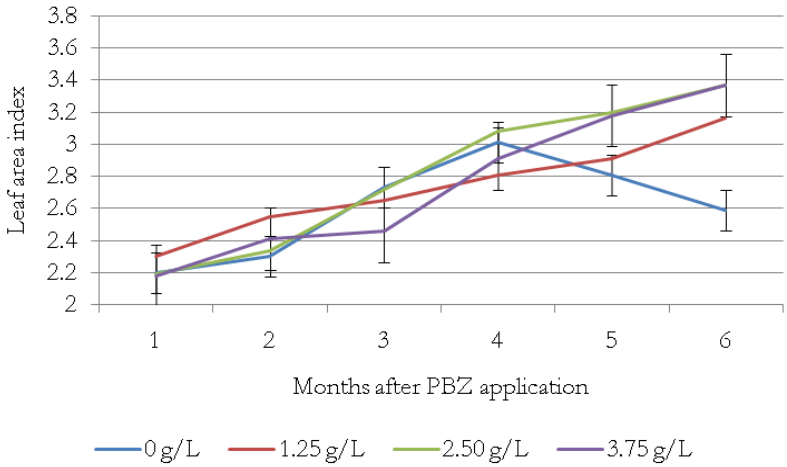

Fig. 4. Effects of PBZ on the LAI of *Syzygium myrtifolium*. Error bars shown are standard errors of means. Error bars for 1.25 g/L and 2.50 g/L PBZ were omitted for clarity.

Demographic Background

Only 30 questionnaire forms were returned, representing 60% of the sample size. They consisted of 80% Malay, 13.3% Indian and 6.7% Chinese. Sixty percent were male while the rest were female. The age of the respondents ranged from 25 to 50 years old. For the educational background, 3.33% of the respondents were PhD holders, 20% were master degree holders, 53.33% were degree holders, 6.67% were diploma holders and 16.67% with *Sijil Pelajaran Malaysia* (SPM). The respondents consisted of a group of people of various occupations related to the landscape industry as shown in Figure 5.

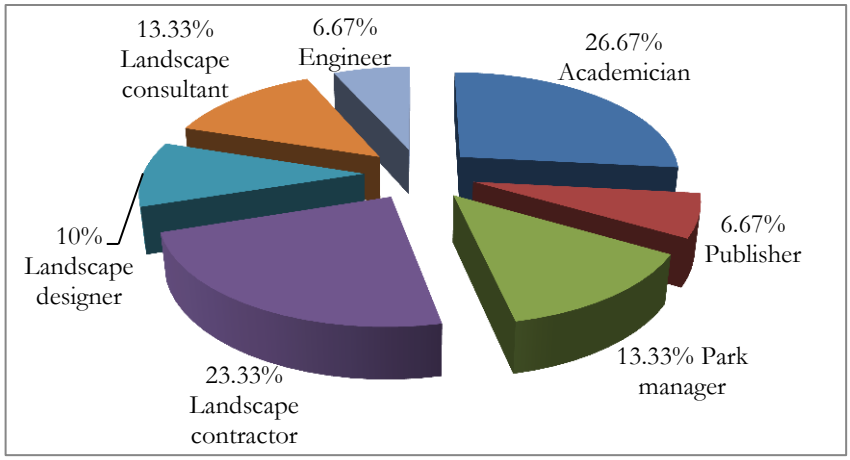

Fig. 5. Distribution of the respondent's occupation

Public Preference of Treated *Syzygium myrtifolium*

Descriptive statistics carried out found that 93.3% of the respondents agreed that the treated *S. myrtifolium* had better appearance than the control *S. myrtifolium* while only 6.7% disagreed (Fig. 6). The respondents who agreed could be attracted to the compacted crown shape of the treated plants while the control plants were irregular in shape. It was also found that 96.7% of the respondents agreed that the aesthetic value of the treated plants increased while 3.3% strongly disagreed (Fig. 6). This result was in line with the findings of Whipker and McCall (2000) who noted that PBZ increased the aesthetic value of potted sunflowers. In addition, Hansen and Alvarez (2010) stated that physical characteristics such as form, texture, size and color gave each plant a distinct look and personality that provided interest, variety and aesthetic appeal to the landscape.

The survey also found that, 93.4% of the respondents were willing to purchase the treated plants while the rest were not certain (Fig. 7). The willing respondents were probably attracted to the dense crown form of the treated plant which also enhanced the plant appearance as compared to those untreated plants with irregular and untidy shape.

It was also found that PBZ increased the market value of the plant. Thirty one percent of the respondents proposed MYR40.00 as the value for the treated *S. myrtifolium*. Remarkably, the suggested value was 100% of price increment when compared to the actual market price (MYR20.00) of the same plant height without PBZ treatment. Unexpectedly, 10% of the respondents offered more than MYR50.00 as listed in the questionnaire form (Fig. 8). These results suggested that PBZ improved the marketability of potted *S. myrtifolium*.

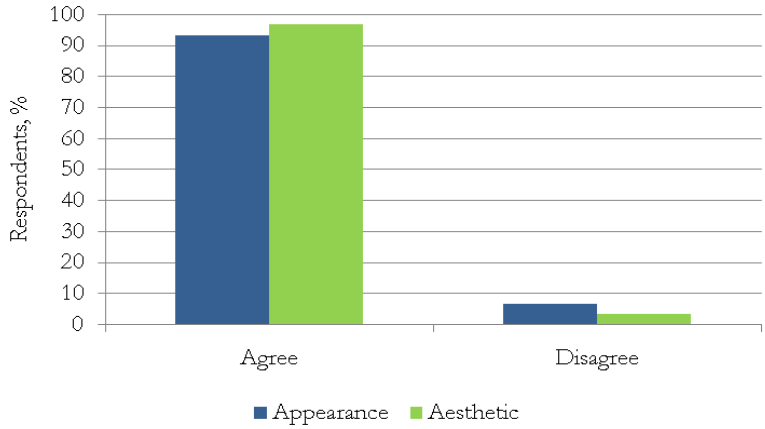

Fig. 6. Public comments on the effect of PBZ in enhancing the appearance and aesthetic value of *Syzygium myrtifolium*.

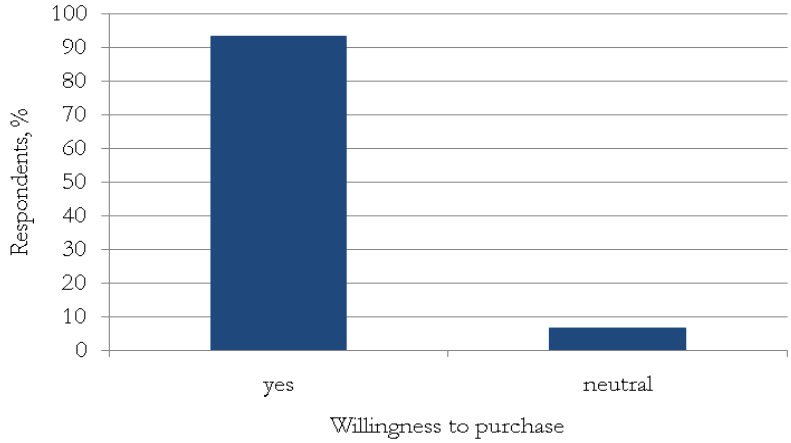

Fig. 7. WTP of the PBZ treated-*Syzygium myrtifolium*

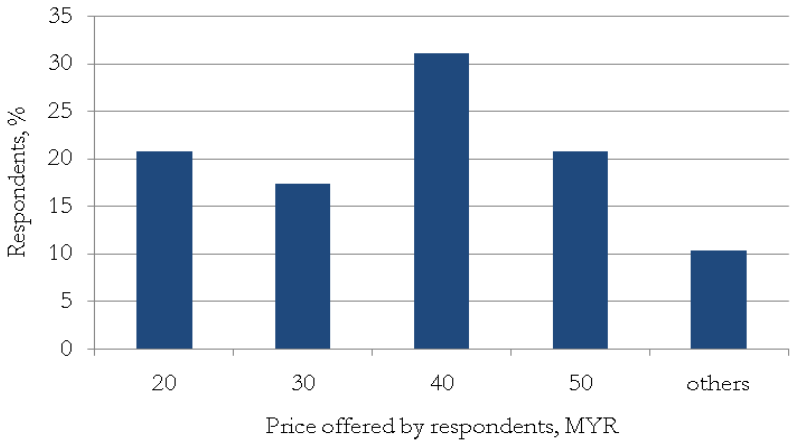

Fig. 8. Price offered by the respondents to the PBZ treated-*Syzygium myrtifolium*

CONCLUSION

PBZ inhibited plant height and LA, but increased the LAI (crown compactness). Application of PBZ was also able to enhance the appearance and aesthetic value of potted *Syzygium myrtifolium*. PBZ also increased the WTP and the market value of the treated *S. myrtifolium*. PBZ has potential as a landscape maintenance tool for reducing the trimming requirement of this vigorous ornamental species. Since there was no significant difference among different rates of PBZ used in the study, 1.25 g/L of PBZ is recommended for maintaining the growth of potted *S. myrtifolium*.

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