

Growth Inhibition of *Syzygium campanulatum* Korth. for Container Planting by the Application of Uniconazole

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ABSTRACT

This study was carried out to determine the optimal dosage of a plant growth regulator, uniconazole, for controlling the growth of *Syzygium campanulatum* for container planting purposes. Uniconazole at ascending rates of 0, 10, 20, and 30 mg l⁻¹ was applied as soil drench to plants grown in polyethylene bags (33 x 27 cm). The application of uniconazole significantly inhibited vegetative growth in terms of height and leaf area. Meanwhile, the most effective application rate of uniconazole for height suppression was 10 mg l⁻¹. The transpiration rate and stomatal conductance of the plants, treated with 30 mg l⁻¹, were slightly lower as compared to the control plants, while the photosynthetic rate was not affected. However, the chlorophyll fluorescence measurement indicated that the application of uniconazole did not affect the photosynthetic performance of this particular species. Uniconazole was able to extend the trimming cycle and would be very helpful in controlling the height of *S. campanulatum* without affecting the physiological processes in the plant.

Keywords: Plant growth regulator, plant physiology, container plant, chlorophyll fluorescence

INTRODUCTION

A local species, *Syzygium campanulatum* with attractive scarlet young foliage, is widely planted in urban landscapes. This species is well adapted in the harsh urban environment. However, it needs frequent trimming due to its vigorous growth. Pruning of landscape trees and shrubs to control excessive vegetative growth and improve plant form is a major expense in landscape maintenance (Keever and Foster, 1990). Meanwhile, disposal of great quantity of trimmed biomass is also a concern in certain countries (Bowles, 1985). Therefore,

an alternative maintenance approach is needed to reduce time and operational cost.

Plant growth regulators have been widely used in reducing vegetative growth and increasing aesthetic value of many ornamental species (Ahmad Nazarudin *et al.*, 2003; Bruner *et al.*, 2001; Mike *et al.*, 1999; Criley, 1997). Among the various triazoles, paclobutrazol, and uniconazole have been found to be the most effective in retarding growth in many plant species (Gilley and Fletcher, 1997). Sponsel (1995) reported that these plant growth regulators inhibited gibberellin (GA) biosynthesis by disturbing the oxidation of *ent-kaurene*. Furthermore, it

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reduces cell elongation and hence retards the plant growth (Barrett, 2001).

The growth of several woody ornamental species was consistently controlled (Wang, 1991; Bruner *et al.*, 2001; Kim *et al.*, 1999) without injury after the application of uniconazole (Norcini and Knox, 1990; Warren, 1990; Keever and West, 1992). Triazole was also found to limit the rates of leaf production and leaf size (Le Cain *et al.*, 1986; Nie *et al.*, 2001). Fuller and Zajicek (1995) found that water use of plants, treated with uniconazole, was reduced by 35 % due to reduction in the leaf area and lower stomatal conductance.

The objective of the experiment was to evaluate the effects of uniconazole on the growth of *S. campanulatum*. The chlorophyll fluorescence study was carried out to confirm that uniconazole did not restrain the species to perform its physiological processes at optimal level.

MATERIALS AND METHODS

The Study Site

This study was conducted at the Forest Research Institute Malaysia (FRIM) in Kepong, Selangor. The seedlings of *S. campanulatum*, with an average height of 105 cm, were obtained from a local nursery in Yong Peng, Johor. They were one year-after planting in the polyethylene bags sized 33 x 27 cm, filled with a mixture of top soil, organic matter and sand, at a ratio of 3:2:1. A total of 16 seedlings were arranged in an open area. The plants were first trimmed to columnar shape with an approximate height of 100 cm. Uniconazole (0, 10, 20, and 30 mg l⁻¹) was applied as soil drenches after the plants had produced new shoots and recovered from the trimming effects (30 days after the trimming). Each rate of uniconazole was replicated four times in a randomised complete block design. The application volume was 1 litre per seedling. At the same time, control plants were applied with 1 litre of plain water. The plants were watered twice daily, or when necessary, depending on the weather. Nitrophoska Green, 15:15:15 (NPK Green), was applied monthly at a rate of 5 g

per plant. Weeds in the polyethylene bags were controlled manually.

Data Collection and Analysis

Plant height (cm) was measured monthly, from the soil surface in the polyethylene bag to the highest shoot tip, using a telescopic height stick. Every month, the first three fully developed leaves from each plant were measured for the leaf area using the leaf area meter (Li-3100 Nebraska, USA). The average of the leaf area was recorded in square centimetres (cm²).

Portable photosynthetic system (Li-6400, Nebraska, USA) was used to measure the photosynthetic rate, transpiration rate, and stomatal conductance. Prior to the measurements, the internal sample carbon dioxide, CO₂ concentration, was adjusted to 400 µmol m⁻² s⁻¹ and the temperature of the leaf chamber was maintained at 28 °C, while the internal radiance provided by a red LED was adjusted to 1500 µmol photon m⁻² s⁻¹ under light-saturated photosynthesis environment. Measurements were recorded at 9.00 am to 11.30 am under full sunlight. The photosynthesis and stomatal conductance were measured in mol m⁻² s⁻¹. Meanwhile, transpiration was measured in mmol m⁻² s⁻¹. Three fully developed leaves from each plant were selected for these measurements.

Chlorophyll fluorescence was also measured in the field at light saturation (I=100%) using a plant efficient analyzer (Hansatech Instruments Ltd., Kings Lynn, UK). The measurement was carried out at five month, after the application of uniconazole. Three fully developed leaves, from each plant, were dark adapted for 20 minutes in a leaf-exclusion clip to the central region of the leaf surface. Dark incubation of pre-illuminated leaves for 20 minutes was sufficient for the chloroplasts to return to the arrangement they had in low light. In this way, the chloroplast movement would not affect the chlorophyll fluorescence parameters. The excitation light for fluorescence was then given to the leaf disc at about 1500 µmol m⁻² s⁻¹ for 5 seconds. The measurements of F_0 (initial fluorescence), F_m (maximum fluorescence), and F_v (variable

fluorescence) were obtained from this procedure. F_v is derived as the difference between F_m and F_0 while the maximum quantum yield of PSII is obtained as F_v/F_m (Owens, 1994).

Statistical Analysis Software (SAS) was used to analyse the data. In addition, Analysis of Variance (ANOVA) was also conducted and the treatment means were then compared using the Tukey's Studentized Range (HSD) test to detect significant difference among the treatments.

RESULTS AND DISCUSSION

The treated plants were found to be significantly shorter ($p < 0.01$) than the control plants (Table 1). However, there was no significant difference among the plants which were treated with different dosages of uniconazole. After five months, the height of the control plant was found to increase about 19.75%, whereas the plant which was treated with 30 mg l⁻¹ uniconazole only had an increase of 1.26%. At this stage, the control plants need to be trimmed to maintain its crown form and landscape function. These results suggested that the plant height gain of *S. campanulatum* was depressed with the application of uniconazole.

Furthermore the treated plants were also found to not producing any curly leaves which would decline the aesthetic value of the plants. The leaves were, however, greener, shinier and smaller as compared to the untreated ones. Visually, the leaves of the treated plants were closely arranged and the crown was more compacted. The leaf area of the treated plants

was significantly smaller ($p < 0.01$) compared to the control plants (Table 2). However, no significant difference was found in leaf area among all the treated plants. At five month after the application, the leaf area of the plants treated with 30 mg l⁻¹ uniconazole was reduced by 48.39%, whereas the control plants were only reduced by 13.83%. These results described the inhibition effects of uniconazole on cell elongation in the leaf. Tonkinson *et al.* (1995) reported that triazoles decreased the size of wheat leaves by the reduction of cell length.

On the contrary, no significant difference was found among all the plants in terms of photosynthetic rate after the application of uniconazole. However, a significant difference ($p < 0.01$) in the transpiration rate and stomatal conductance were demonstrated between the controls and the plants which were treated with 20 and 30 mg l⁻¹ uniconazole (Table 3). It showed that the transpiration rate and stomatal conductance were reduced as the uniconazole rate increased. The results also suggested that the amount of water released from the stomata was more for the control plants as compared to the treated plants, except for those treated at a rate of 10 mg l⁻¹. Wang and Lin (1992) indicated that the transpiration rate might vary following the treatment with triazoles, depending on the species. In this study, the smaller leaf area developed in the treated plants might have reduced the transpiration rate. The reduction in the transpiration rate would protect the plant against abiotic stress due to water restriction or drought period (Olsen and Andersen, 1995).

TABLE 1
The plant height of *S. campanulatum* after treatment with uniconazole

Uniconazole (mg l ⁻¹)	Plant height (cm)					
	Month after application					
	0	1	2	3	4	5
0	100.00a	108.25a	112.25a	114.25a	116.50a	119.75a
10	99.25a	101.50b	101.75b	102.00b	102.00b	102.50b
20	99.25a	101.25b	101.75b	102.00b	102.00b	102.50b
30	99.50a	100.50b	100.50b	100.75b	100.75b	100.75b

Means followed by the same letter(s) within the column do not differ by Tukey's Studentized Range Test at $p < 0.01$

TABLE 2
The leaf area of *S. campanulatum* after treatment with uniconazole

Uniconazole (mg l ⁻¹)	Leaf area (cm ²)					
	Month after application					
	0	1	2	3	4	5
0	11.21a	11.06a	10.17a	9.78a	9.46a	9.66a
10	11.11a	8.42b	7.36b	6.84b	6.22b	6.32b
20	11.31a	7.92b	6.98b	6.74b	6.35b	6.06b
30	11.18a	7.25b	6.79b	6.43b	6.06b	5.77b

Means followed by the same letter(s) within the column do not differ by Tukey's Studentized Range Test at $p < 0.01$

TABLE 3
The influence of uniconazole on photosynthetic rate, transpiration rate and stomatal conductance of *S. campanulatum* at five month-after the treatments

Uniconazole (mg l ⁻¹)	Photosynthetic rate ($\mu\text{mol m}^{-2} \text{s}^{-1}$)	Transpiration rate ($\text{mmol m}^{-2} \text{s}^{-1}$)	Stomatal conductance ($\text{mol m}^{-2} \text{s}^{-1}$)
0	6.76a	2.45a	0.22a
10	5.02ab	2.15ab	0.20a
20	5.36ab	1.48bc	0.11b
30	4.29ab	1.26c	0.10b

Means followed by the same letter(s) within the column do not differ ($p < 0.01$) by the Tukey's Studentized Range Test

In this study, no significant difference in F_0 , F_m , F_v , F_v/F_m , and F_m/F_0 values in *S. campanulatum* were found (Table 4). The average F_v/F_m values were 0.83, showing that the plants were able to perform its physiological processes at the optimum level. According to Bjorkman and Deming (1987) and Johnson *et al.* (1993), the optimum value of 0.83 was measured for most plant species. This result showed that *S. campanulatum* was able to adapt with the application rates of uniconazole. Govindjee *et al.* (1981) reported that water is not a limiting factor for the plant's physiological processes if the F_m/F_0 ratio was above 3.0. This observation has a strong relationship with the previous results, where the treated plants had lower transpiration rate which reduced water lost through the stomata.

CONCLUSIONS

Uniconazole was found to be capable of extending the trimming cycle and would be very helpful in controlling the height and shape of *S. campanulatum*. In this study, different dosages of uniconazole did not show any differences in the plant height, suggesting that the lowest dosage of uniconazole, i.e. 10 mg l⁻¹, was more practical to be used in managing the growth of this species. This compound reduced the leaf area but no curly leaf formation was observed. Uniconazole caused variations in the transpiration rate and stomatal conductance, which were possibly due to the smaller leaves developed. However, the application of uniconazole did not affect this species to perform its physiological processes at the optimal level.

TABLE 4
Chlorophyll fluorescence values of *S. campanulatum* at five month-after treatment with uniconazole

Uniconazole (mg l ⁻¹)	F ₀	F _m	F _v	F _v /F _m	F _m /F ₀
0	72.50	437.00	364.10	0.83	6.03
10	110.75	674.50	560.75	0.83	6.09
20	84.00	505.75	417.95	0.83	6.02
30	82.25	495.5	413.00	0.83	6.02

ANOVA showed no significant difference at p<0.01

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