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Interactive effects of shading and nitrogen on the foliage quality and growth of *Dracaena godseffiana* cv. 'Florida beauty'

(Kesan interaktif naungan dan nitrogen terhadap mutu daun dan pertumbuhan *Dracaena godseffiana* kv. Florida beauty')

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Key words: *Dracaena godseffiana*, foliage quality, growth, nitrogen, shading

Abstrak

Satu kajian telah dijalankan untuk menilai kesan interaktif antara aras naungan dan N bagi meningkatkan mutu daun dan pertumbuhan *Dracaena godseffiana* kv. Florida beauty'. Pokok berkenaan ditanam di bawah tiga aras naungan (30, 50 dan 70%) dan empat aras N tambahan (0, 5, 10 dan 15 g urea/bekas). Naungan yang tebal (70%) didapati meningkatkan kandungan klorofil daun. Daun-daun yang dihasilkan oleh pokok di bawah naungan 70% mempunyai ketepuan warna yang tinggi. Pertambahan N telah meluaskan permukaan daun dan berat kering pokok tetapi N tidak mempengaruhi kandungan klorofil dan warna daun. Kandungan N dalam daun bertambah dengan pertambahan N dalam tanah. Oleh sebab bekalan yang terhad dan pokok pula lebih besar, kandungan P dan K dalam daun menjadi berkurangan bagi pokok yang diberi N tambahan. Perubahan aras naungan tidak mempengaruhi kandungan nutrien dalam daun.

Abstract

A study was conducted to evaluate the interactive effects of shade level and N on improvement of foliage quality and growth of *Dracaena godseffiana* cv. Florida beauty'. Young plants were exposed to three shade levels (30, 50 and 70%) and four additional N levels (0, 5, 10 and 15 g urea per container). Heavy shading (70%) enhanced the concentration of leaf chlorophyll. Leaves produced by plants grown under 70% shade had a stronger colour saturation. Additional N increased leaf area and plant dry weight but N did not affect leaf chlorophyll content and leaf colour. Leaf N content increased with increasing N availability. Due to limited supply and a more vigorous growth, leaf P and K contents were lowered under high N conditions. Variations in shading did not affect leaf nutrient concentration.

Introduction

Dracaena godseffiana is a beautiful and attractive foliage ornamental plant. The plants are frequently used as potted indoor plants or cut foliage. Besides plant form, the aesthetic value of the plant depends very much on the coloration of its leaves. The leaves are considered 'good' when they are 'green' and interspersed with creamy spots.

Dracaena godseffiana is characterized as a shade-loving plant. When grown under high irradiance level, its leaves will be 'whitish' and scorched (Rukayah 1995). For this reason, the plants are generally grown

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under low irradiance condition (Manaker 1987; Conover 1992). However, with low available irradiance, plants normally allocate or divert more energy into producing light-harvesting pigments (Salisbury and Ross 1992). Under such conditions, the leaves would look greener due to the increased chlorophyll content but the plant's overall growth might be reduced, including its branching ability. This would result in a reduction in plant volume and accordingly fewer number of cut foliage may be harvested. Increased nutrient, especially nitrogen, may promote shoot initiation and overall growth, and possibly increase the number of shoots (stems) while maintaining high quality foliage. This study was conducted to verify this hypothesis.

Materials and methods

Experimental treatments

Young *Dracaena godseffiana* cv. Florida beauty' plants, established in polybags, were transferred into 20 cm plastic containers. The planting medium consisted of 2 parts top soil: 1 part organic matter: 1 part sand (volume basis). Two kilograms of ground magnesium limestone was incorporated in every cubic metre of medium. Five plants were planted in every container and placed on wooden benches at a spacing of 20 cm between containers. The plants were fertilized with a compound fertilizer containing 15% N, 15% P_2O_5 and 15% K_2O, at a rate of 10 g per container every 2 months. The plants were irrigated twice daily using a spray jet system.

Immediately after establishment in the container, the plants were grown under different shade levels, obtained by suspending black flat-twisted polyethylene nettings with different light penetration levels at approximately 1.5 m above the plant canopy and at all sides. The shade levels of netting used were (as designated by the supplier): 30, 50 and 70%. The plants under each shade level were then divided into four groups and the groups were supplied with four levels of additional N: 0, 5, 10 and 15 g urea (46% N) per container respectively. The plants were arranged in a split-plot design with shade as main plot and N as sub-plot. The treatments were replicated four times with eight plants per sub-plot. The experiment was conducted at MARDI Research Station, Serdang, Selangor.

Data collection

Foliar analysis Leaf chlorophyll content, leaf nutrient concentration and leaf colour were determined 6 months after the start of the experiment. Eight young fully expanded leaves (normally the 2nd and 3rd leaves) from each branch were used for chlorophyll determination. Immediately after harvest, the leaves were chopped into small pieces. Chlorophyll in 1 g fresh leaf was extracted by grinding in 80% acetone using a mortar and pestle. After filtration, the absorbance of each sample was measured at wavelength 650 nm. Total chlorophyll content was calculated according to Arnon (1949). For determination of leaf nutrient concentration, leaves sampled from four branches (stems) of each sub-plot were used. Leaf P and K, extracted using hydrochloric and nitric acids, were determined using an inductively coupled plasma (ICP) emission spectrometry technique (Ahmad 1993). Leaf N was extracted using the Kjeldahl digestion procedure and its concentration determined using an autoanalyser (Technicon Autoanalyser II, Technicon Instruments Corp., Tarrytown).

Leaf colour was measured using a chroma meter (Minolta chroma meter CR-200, Ramsey, N.J.) with L^* (measures lightness), a^* (measures red-green characters) and b^* (measures yellow-blue characters) system. The a^* and b^* values were then transformed to give hue angle ($\tan^{-1} b^*/a^*$ - indicates colour) and chroma [$\sqrt{(a^{*2} + b^{*2})}$ - indicates colour brightness or saturation)] (Mc Guire 1992). There were 16 measurements taken on each sub-plot from eight leaves (two measurements per leaf), and the measurements were done on the green spots of the leaves.

Plant growth At the end of the study (12 months after treatment), the stems of all plants in four containers per sub-plot were harvested by cutting at the growing medium level and separated into their principal components. Leaves and stems were counted, and their leaf area, stem length and leaf thickness measured. Leaf area was determined with a Li-Cor area meter (Li-Cor, Inc. Lincoln USA). Plant dry weight was determined after drying the samples at 80 °C in a forced-draft oven for 48 h.

Results

Leaf chlorophyll and nutrient contents

Variations in leaf chlorophyll content in response to changing shade and N levels are shown in *Figure 1*. Overall, leaf chlorophyll increased significantly (p <0.001) as shade level increased to 70% and this is true at all N levels. There was no difference in chlorophyll content between 30% and 50% shading. The beneficial effect of additional N on chlorophyll content at the first two shade levels was only noticed up to 5 g urea per container.

Increasing N from 0 to 5 g urea per container led to a significant increase in leaf N content. However, increasing N from 5 to 15 g urea per container did not affect leaf N content at all shade levels which remained constant between 2.02% and 2.13% *(Table 1).* Nevertheless, elevated N reduced the concentration of P and K in dried leaves. Leaf N, P, and K were unaffected by shading.

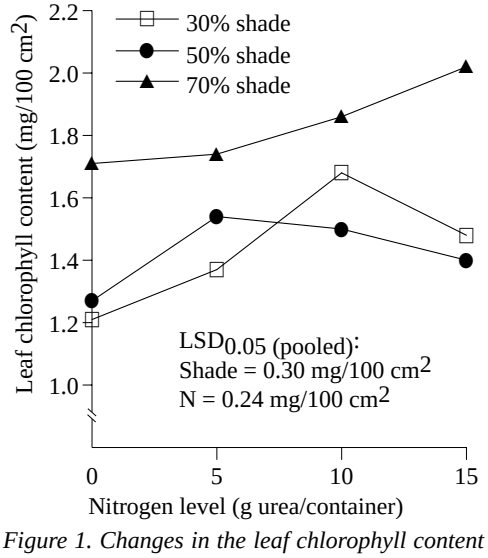

*Figure 1. Changes in the leaf chlorophyll content of **Dracaena godseffiana** plants grown under different shade and N levels*

Leaf colour

Results of instrumental colour measurement are presented in *Table 2*. L^* values were reduced only at the heaviest shade level (p <0.05) which indicated that leaves produced under this condition were darker than those produced at lower shade levels. Reduction in L^* values was also observed at the highest N level (p <0.05). The colour of the leaves developed under the heaviest shade level was greener (stronger colour saturation) as indicated by higher chroma values. Differences in shade and N levels did not affect actual colour of the leaves as shown by no marked difference in hue angles among treatments.

Plant growth

The effects of shading and N on growth parameters varied between plant components *(Table 3).* Increasing shade level to 70% reduced the number of stems (p <0.05). There was no marked difference in the stem number between 30% and 50% shade levels. The change in dry matter accumulation in response to available irradiance depended on N levels as shown by a significant interaction between shade level and N rate (p <0.05) for plant dry weight *(Figure 2).* Generally, under high irradiance condition (lighter shade), the beneficial effect of high N on plant dry weight can be seen at 15 g urea per container. Increased N levels from 5 to 15 g urea per container did not produce any significant effect on plant dry weight at the other two shade levels. At all N levels, dry weights of plants grown under 70% shade were the lowest compared to those grown under the other lower shade levels.

Increasing N level from 0 to 5 g urea per container elevated leaf area from 1 700 cm^2 to 2 298 cm^2 (p <0.01, *Table 3*).

Table 1. Effects of shade and N on leaf N, P and K contents (dry weight basis)

Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Shade level (%)			
30	1.87a	0.26a	1.80a
50	1.91a	0.36a	1.90a
70	1.91a	0.23a	1.92a
F-test	ns	ns	ns
N level (g urea/container)[1]			
0	1.42b	0.50a	2.28a
5	2.03a	0.20b	1.76b
10	2.02a	0.18b	1.76b
15	2.13a	0.17b	1.67b
F-test	***	***	***
F-test (shade x N)	ns	ns	ns

[1]Additional N, excluding those supplied by compound fertilizer (15:15:15)
Mean values in each column with the same letter are not significantly different at $p > 0.05$ according to DMRT

Table 2. Effects of shade and N on leaf colour of *Dracaena godseffiana* cv. 'Florida beauty'

Treatment	Colour components		
	Lightness	Hue	Chroma
Shade level (%)			
30	71.9a	86.67a	18.79b
50	72.2a	86.94a	19.30b
70	69.6b	85.71a	24.80a
F-test	*	ns	**
N level (g urea/container)[1]			
0	71.1a	86.76a	20.00a
5	71.6a	86.23a	21.22a
10	71.6a	87.17a	20.57a
15	70.1a	85.60a	22.08a
F-test	ns	ns	ns
F-test (shade x N)	*	ns	ns

[1]Additional N, excluding those supplied by compound fertilizer (15:15:15)
Mean values in each column with the same letter are not significantly different at $p > 0.05$ according to DMRT

Table 3. Effects of shade and N on the growth of *Dracaena godseffiana* cv. 'Florida beauty'

Treatment	Stem no. (per plant)	Leaf area (cm^2/plant)	Stem length (cm)	Leaf no. (per stem)	Leaf thickness (mm)
Shade level (%)					
30	12.7a	2 180a	32.8a	15.1a	0.338a
50	13.2a	2 263a	32.5a	15.7a	0.341a
70	11.1b	1 915a	34.5a	15.3a	0.342a
F-test	*	ns	ns	ns	ns
N level (g urea/container)[1]					
0	11.9a	1 700b	31.8a	15.2a	0.34a
5	13.0a	2 298a	35.6a	16.0a	0.35a
10	12.2a	2 150a	32.2a	15.5a	0.34a
15	12.3a	2 329a	33.5a	14.8a	0.33a
F-test	ns	**	ns	ns	ns
F-test (shade x N)	ns	ns	ns	ns	ns

[1]Additional N, excluding those supplied by compound fertilizer (15:15:15)
Mean values in each column with the same letter are not significantly different at $p > 0.05$ according to DMRT

However, there was no further increase in leaf area even when N levels increased from 5 to 15 g N, as the leaf area remained between 2 150 cm^2 and 2 329 cm^2. Stem length, number of leaves per stem and leaf thickness were not affected by the treatments.

Discussion

Reduced irradiance enhanced leaf chlorophyll content and leaf colour saturation, suggesting an improvement in the appearance of foliage. Results recorded here are consistent with the earlier findings on other shade-loving species such *as Polycias*

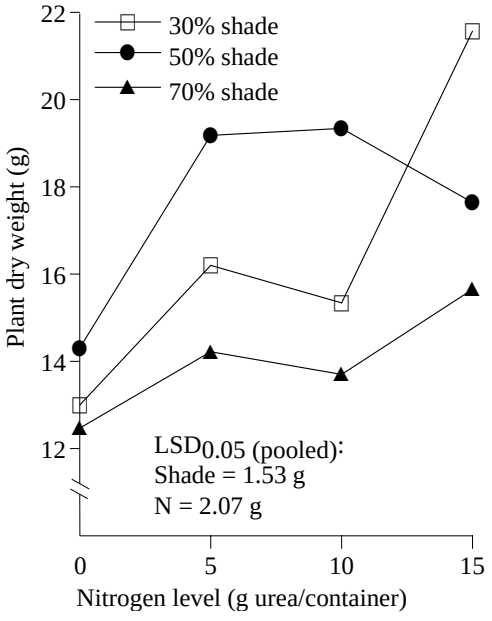

*Figure 2. Changes in the dry weight of **Dracaena godseffiana** plants grown under different shade and N levels*

guilfoyle, *Dracaena sandreana* and *Alocasia cuprea* (Aasha and Nair 1992), *Ficus benjamina* (Brasswell et al. 1982; Fails et al. 1982) and *Schefflera arboricola* (Brasswell et al. 1982). Conover and Poole (1984) reported that leaf chlorophyll levels of *Dracaena marginata* increased from 0.055 mg/cm^2 in sun-grown plants to 0.081 and 0.100 mg/cm^2 when the plants were grown under 40% and 80% shade respectively for 6 months. Similar effects from high irradiance were also recorded for some sun-loving plants (Sorrentino et al. 1997). Generally, shiny and greener leaves are considered more attractive and are preferred by the consumer. In addition, although not determined in this study, plant materials produced at low irradiance tend to have a higher water potential and moisture content (Awang and Atherton 1994), and therefore when used as cut foliage, such materials would have a better water absorption capacity and perhaps a longer shelf life.

At low irradiance (70% shade), the changes in chlorophyll content occurred independently of N level. This result revealed that plants grown under low irradiance have the ability to maintain their photosynthetic capacity by investing more energy in light-harvesting pigments. Exposure to high irradiance, on the other hand, could be detrimental as it may cause photoinhibition and destruction of pigments, thus lowering photosynthetic rate (Demmig and Bjorkman 1987; Ogren and Evans 1992). This is clearly reflected by low leaf chlorophyll content in plants grown under high irradiance (low shade level) even when supplied with higher N *(Figure 1).*

Additional N markedly increased leaf N concentration but its positive effect was only apparent up to 5 g urea per container. This does not necessarily reflect that the additional N was a waste but could be associated with dilution effects following more vigorous plant growth. Although the leaf N concentration remained constant between 2.02% and 2.13% (dry weight basis), the overall N uptake by plants grown in higher N was higher due to bigger leaf areas *(Table 3).* Due to limited supply and vigorous growth, the concentrations of leaf P and K were lowered in plants grown at high N levels.

The beneficial effect of higher N can be seen in the increase in plant leaf area and plant dry weight. As the number of stems, number of leaves per stem and hence leaf number per plant remained constant, increased leaf area at higher N must be due to larger individual leaf. Such an effect can be viewed as positive as use of foliage with larger leaves will require a smaller number of cuttings for flower arrangements or indoor landscaping.

The growth of the plant was reduced when grown under 70% shade as shown by a significant reduction in plant dry weight. This trend of result is well documented. However, the magnitude of the negative effect of shade observed here was much smaller than that of sun-loving plants for which lowering irradiance by 1% will result in about 1% reduction in plant dry matter (Cockshull 1988; Awang and Atherton

1995). In this study, the overall reduction in dry matter accumulation was only 15.2% as the shade level increased from 30% to 70%. The smaller negative effect of shade on shade-loving plants is generally related to their ability to acclimatize in a new environment, for example through reduction in light compensation point and lower respiration rate (Conover and Poole 1984). Such ability has made this species suitable for indoor use.

In conclusion, the results of the study showed that the foliage quality and growth of *Dracaena godseffiana* cv. 'Florida beauty' can be effectively regulated by changing the shade and N levels. A shade level of 70% can be used for successful production of this plant species. Information on the role of N in foliage quality generated from this study is not conclusive as the effects of N on the parameters measured may only be operational when an adequate supply of other nutrients are made available.

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