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Influence of Different Spectral Filters on The Colour of Foliage CodiaeumVariegatum L. Var. Sunny Star (Croton) During Two Distinct Seasons

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ABSTRACT

Export standard foliage of Codiaeumvariegatum L. var. Sunny Star has predominantly green colour leaf blade mottled with yellow patches. The colour and mosaic design of the foliage depends on light intensity and quality. In Sri Lanka, high light intensity in the field and lower intensity under black shade nets results in either more yellow or greener leaves than the preferred export standard. Thus the objective was to achieve the export standards of leaf colour: 30 – 40% yellow colour development on leaves by growing plants under five different spectral filters (coloured shade nets); red, silver, white, black (with 60% shade) and black (with 80% shade), and full sunlight during two distinct seasons, Inter-monsoon 2 and Maha to Inter-monsoon 1 at the agro-climatic zone, WM3 in Sri Lanka. For C. variegatum L. var. Sunny Star, 30-40% of the yellow colour on the lamina was obtained when grown under silver colour spectral filters in Inter-monsoon 2 season wherethe incidence radiation was relatively low. The same leaf colour distribution was found under white spectral filter in Maha to Inter-monsoon 1 season where the incidence radiation was relatively high. Red shade nets developed excessively yellow leaves where yellow leaf area exceeded 40% while black shade nets gave excessively green coloured leaves. In conclusion, the export quality of C. variegatum var. Sunny star foliage can be attained by growing plants under either silver spectral filters (if the incidence light intensities are low) and white colour spectral filters (if the incidence light intensities are high).

KEYWORDS: *Codiaeumvariegatum, leaf colour, light intensity, spectral filters*

1 Introduction

Codiaeumvariegatum L. var. Sunny Star belonging to family Euphorbiaceae, is one of the most popular ornamental cut-foliage exported from Sri Lanka. For C. variegatum var. Sunny Star, the leaf colour distribution required for the export market is 30 – 40% yellow colour mottling on predominantly dark green leaf blade (Mike flora, 2014). The colour and mosaic design of the foliage depends highly on light intensity and quality. In Sri Lanka, high light intensity in the field and lower intensity under black shade nets results in either more yellow or greener leaves than the preferred export standard. Thus to maintain the colour of the foliage within the acceptable export standards, optimisation of light intensity and spectral quality is a necessity.

Thus the objective was to achieve 30 – 40% yellow colour development on leaves of plants by growing under five different spectral filters (coloured shade nets); red, silver, white, black (with 60% shade) and black (with 80% shade), and control kept under full sunlight during two consecutive seasons in mid-country intermediate zone (WM3) of Sri Lanka.

2 Materials and Methods

The experiment was conducted at the Mike Flora (Pvt.) Ltd., Rambukkana (in WM3) of Sri Lanka during Inter-monsoon 2 season (October to November) in 2013 and Maha to Inter-monsoon 1 seasons (January to May) in 2014. Five different spectral filter treatments with the full sunlight control were laid out in a randomized complete block design, keeping four replicates. Plants were placed under different spectral filter treatments and direct sunlight after a regular pruning practice. The light intensities under different coloured spectral filters were measured using a lux meter, and the quantum sensor (Table 1). Relative humidity and temperature were recorded using wet and dry bulb thermometer and a portable thermometer respectively (Table 2). The leaf area of the whole leaf and yellow coloured area were estimated using a grid chart at the end of the season and the percentage of yellow leaf area was computed. The data were subjected to Analysis of Covariance (ANCOVA) and Bonferroni mean separation. All analyses were performed using MINITAB 16.0. Significances were defined at $P < 0.05$.

3 Results

In Maha to Inter-monsoon 1 season in 2014, the intensity of incidence radiation was 1.6-fold higher compared to Inter-monsoon 2 season in 2013 (Table 1). Plants under spectral filters too received 130 – 270 % higher transmitted light during Maha to Inter-monsoon 1 season than Inter-monsoon 2 season (Table 1). Hence, Maha to Inter-monsoon 1 season in 2014 was hotter and drier than during Inter-monsoon 2 season in 2013 (Table 2).

The standard colour development for the export market was obtained under silver colour shade net in Inter-monsoon 2 while in Maha to Inter-monsoon 1 in 2014, white shade net also gave the desired results (Table 3). Yellow colour development in the foliage under other colour shade nets did not reach the export standard. For example, under red nets, the yellow coloured area exceeded 40% of the total leaf area whereas under black nets, leaf yellowness was <30% due to excessive green colour development (Table 3).

Table 1: Light intensities under different treatments

Treatments[1]	Light intensity (Wm^{-2})		Ratio of light intensities[2]
	Inter-monsoon 2 season[3]	*Maha to Inter-monsoon 1* season[4]	
Red (40%)	233.0 ± 19.3	571.4 ± 32.2	2.5
Silver (40%)	117.5 ± 9.3	432.3 ± 25.3	3.7
White (50%)	125.4 ± 8.5	287.3 ± 17.9	2.3
Black (60%)	71.5 ± 5.0	218.1 ± 17.8	3.1
Black (80%)	32.0 ± 2.6	117.9 ± 9.2	3.7
Control[5]	486.0 ± 24.5	790.5 ± 36.7	1.6

[1]Values in parenthesis represent shade percentage specified by the manufacturer for different spectral filters

[2]Under treatments between seasons; *Maha to Inter-monsoon 1: Inter-monsoon 2*

[3]Mean±SE (*n=4*)
[4]Mean±SE (*n=16*)
[5]100% sun light treatment indicating the intensity of incidence radiation

Table 2: Climatic conditions at the experimental site (open field)

Seasons	Maximum temperature (° C)	Relative humidity(%)
Inter-monsoon 2[1]	26.8±0.7	64.6±1.4
Maha to Inter-monsoon 1[2]	35.5 ±0.7	49.1±2.3

[1]Mean±SE (*n=4*)
[2]Mean±SE (*n=16*)

In both seasons, red spectral filters resulted in highest leaf yellowness, which were 60% and 30% higher than yellowness obtained under control receiving full sunlight (Table 3). In Inter-monsoon 2, the season with lower incident light, the lowest leaf yellowness (5 – 21%) was obtained under black net and white shade net (Table 1 and 3). However, in Maha to Inter-monsoon, the season with high light intensities (Table 1), the leaf yellowness was not significantly different among spectral filters, compared to the control ($p>0.05$; Table 3).

Table 3 : Effect of treatments on percentage yellow colour leaf area of Codiaeumvariegatum L. var. Sunny star in the two seasons1

Treatments[2]	*Inter-monsoon 2*	*Maha to Inter-monsoon 1*
Red (40%)	79.1 ± 2.5[a]	70.8± 6.2[a]
Silver (40%)	36.0 ± 4.5[bc]	48.5± 7.0[a]
White (50%)	13.3 ± 4.0[cd]	35.5± 5.3[a]
Black (60%)	20.5 ± 1.7[c]	18.1± 4.9[a]
Black (80%)	04.7 ± 1.9[d]	8.6 ± 3.4[a]
Control[3]	47.4 ± 1.8[b]	52.7± 6.3[a]

[1]Mean±SE (*n=4*), Means with different letters within a column are significantly different ($p<0.05$).
[2] Values in parenthesis represent shade percentage specified by the manufacturer for different spectral filters
[3] 100% sun light treatment indicating the intensity of incidence radiation

4 Discussion

Clear sky under fairly dry weather during Maha to Inter-monsoon 1 season resulted more incidence radiation on C. variegatum plants (Tables 1 and 2). Under this situation, in Maha to Inter-monsoon 1, plants grown under white colour spectral filter achieved the required export standard by turning 36% of the lamina to yellow (Table 3). In contrast, less incidence radiation under cloudy sky (under rainy weather) in Inter-monsoon 2 (Table 1-3), the radiation transmission by white spectral filter was not adequate to meet the required export standard of the leaf colour (Shahak et al., 2004). In Inter-monsoon 2, the season with lower incident light, to obtain export standard, silver colour spectral filter was necessary. However, radiation transmission by silver spectral filter (compared to white) transmitted too high intensity during Maha to Inter-monsoon 1 season (Table 3), resulting the percentage yellow colour to exceed the export standards. Hence the light intensity required for maintaining the required leaf colour development of C. variegatum L. var. Sunny Star might be provided by white spectral filter during high (791±36.7 Wm-2) incidence radiation and by silver colour spectral filter during low (486±24.5) incidence radiation because at silver colour spectral filter scatters light better increasing radiation penetration in to the canopy (Shahak et al., 2004).

However, in Intermonsoon 2, both silver and white spectral filters had the same levels of transmitted radiation (Table 1) but did not result in similar levels of yellow colour percentage on leaves (Table 3) which was similar to variegation levels observed in Philodendron spp. under different coloured shade nets (Stamps and Chandler, 2008). Hence, the spectral quality of different colour nets also seems to have an additive effect on the pigmentation on the foliage of croton, as described by many authors (Oren-Shamir et al., 2001; Stamps and Chandler, 2008), probably at low levels of incidence radiation.

Excessive yellow colour development in leaves under red spectral filters and full sunlight (control) in

either season may be an effect of too high light intensities or differences in indirect (scattered/diffused) light specially under red filter (Oren-Shamir et al., 2001). This is further assured by very low yellow colour spread shown under too low light transmission (high shade) by black spectral filters in both seasons. The effect of shade levelson the yellow and greenish pigmentation in C. variegatum L. var. Sunny Star agrees with the earlier reports (Sophonputtanaphoca et al., 2000).

5 Conclusions

For C. variegatum L. var. Sunny Star, the export standards of leaf colour was obtained when grown under silver colour spectral filters in season with relatively low incidence radiation while under white spectral filters in seasons with relatively high incidence radiation.

References

Oren-Shamir, E.E., Gussakovsky, E., Shpiegel, A., Nissim-Levi, K., Ratner, R., Ovadia, Y.E., Giller and Shahak Y. (2001).Coloured shade nets can improve the yield and quality of green decorative branches of *Pittosporumvariegatum*. *Journal of Horticultural Science and Biotechnology* , 76:353–36pp.

Personal communication (2014). Mike Flora (pvt.) Ltd., Sir iNiwasa, Rambukkana, Sri Lanka.

Sophonputtanaphoca, S., C. Supachitra and B. Preeda (2000).Adaptation of croton 'Baisom' [*Codiaeumvariegatum* (L.) Bl. 'Baisom'] leaves to different light intensities. *Journal of Science Research,* 25: 257-269.

Shahak, Y., Gussakovsky, E.E., Gal E. and Ganelevin R. (2004).ColorNets: Crop protection and light-quality manipulation in one technology. *Acta Horticulture*, 659:143-151.

Stamps, R.H. and Chandler, A.L. (2008).Differential effects of colored shade nets on three cut foliage crops.*Acta Horticulture* (ISHS) 770:169-176.