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# Effects of graded shade levels on the growth and quality of *Cordyline fruiticosa* variety 'Purple Compacta' in the Batticaloa district

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## ABSTRACT

*Cordyline fruticosa is a popular foliage plant and it has high demand in the export market. Shade influences the growth and quality of ornamental foliage plants. An experiment was conducted to determine the effects of different shade level on the growth and quality of C. fruticosa var. 'Purple Compacta' in the Crop Farm, Eastern University, Sri Lanka. Graded shade levels were defined as treatments viz. 0% (T1), 50% (T2), 60% (T3), 70% (T4), and 80% (T5). The experiment was arranged in a completely randomized design with three replications. Recommended agronomic practices were followed uniformly for all treatments. Plant height, leaf area, and plant biomass were measured at monthly interval and quality of cuttings was assessed at 3 months after transplanting. Analysis of Variance was performed to determine significant difference among treatments ($p < 0.05$). Results revealed that plants grown at 50% shade level (T2) obtained significantly ($p < 0.05$) higher plant height, leaf area, plant biomass and biomass partitioning. In quality assessment, plants grown at 50% shade level received significantly ($p<0.05$) highest scores. Plants performance was lower in other treatments. It could be concluded that, 50% shade level is suitable for growing C. fruticosa var. 'Purple Compacta' in the Batticaloa district as the growth and quality of plants were higher.*

**Key words**: *Biomass partitioning, Dryzone, Leaf area, plant biomass, shade levels.*

## Introduction

*Cordyline fruticosa* is a popular foliage plant belongs to family Asparagaceae. It is an evergreen foliage plant grown in houses or outdoors and it has high demand in the export markets as cut decorative foliage (Weerahewa and Somaratne, 2011). It is also popular as potted plant (Kobayashi *et al*., 2007). The agro-climatic diversity in Sri Lanka is very much beneficial for the production of foliar ornamentals and cut flowers. In Sri Lanka, *C. fruticosa* is commercially produced for export markets (Anon, 2012). However, commercial floriculture nurseries are mainly found in the central uplands and the lowlands in western and north-western regions (Weerakkody, 2004). Batticaloa is an important agricultural district in the dry zone of Sri requirements of *C. fruiticosa* are compatible to the prevailing climatic conditions in Batticaloa district and therefore this crop can be selected as a foreign income earner to this area. However, there is no information available regarding the optimal light intensity for *C. fruiticosa* in the Batticaloa district. An important ecological factor to be considered to any cultivated species is the best irradiance level (Mattana, *et al.*, 2006). Shade levels affect growth and quality of ornamental foliage plants (Oren-Sharmir *et al.*, 2001) and provision of shade is recommended for the cultivation of foliage plants. Therefore, proper shade level is necessary in nurseries where, *C. fruiticosa* plants are being grown. As Sri Lanka has different climatic conditions across the island, regional specific researches are needed to

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cultivation of *C. fruiticosa* in a particular location. A better understanding of possible influence of different shade levels on the growth, development and quality of *C. fruiticosa* could lead to development of recommendation for the agronomic management of different varieties of *C. fruiticosa* in the dryzone of Sri Lanka. Hence objective of this experiment was to determine the effects of graded shade levels on growth and quality of *C. fruiticosa* var. 'Purple Compacta' and to select optimum shade level for the cultivation of *C. fruiticosa* var. 'Purple Compacta' in the Batticaloa district of Sri Lanka.

**Materials and methods**

A shade house experiment was conducted from October 2015 to March 2016 at the Crop Farm, Eastern University, Vantharumoolai, Batticaloa, located in low country dry zone of Sri Lanka. Experiment was arranged in a completely randomized design (CRD). Graded levels of shade were defined as treatments viz. 0% (T1), 50% (T2), 60% (T3), 70% (T4), 80% (T5). Each treatment contained 30 replications. An experimental unit consisted of one plant. Plants were arranged at a spacing of 30 plants per $m^2$. Uniform sized rooted cuttings of *C. fruticosa* variety 'Purple Compacta' were obtained from Tropical Abundance (Pvt) Ltd, Giriulla and treated with fungicide (Captan®) before planting. The cuttings were planted into polybags (diameter and height of the bags were 30 cm) filled with Potting media containloam soil, compost, cattle manure and sand in a ratio of 4: 2: 1: 1 (volume basis) as per Department of Agriculture recommendation (2002). Other management practices were followed uniformly according to the recommendation. Plants were destructively sampled monthly in all treatments during the experiment. Plant height (cm), leaf area per plant ($cm^2$), plant biomass (g), biomass partitioning (%) were taken as measurements. Analysis was carried out using Statistical Analysis System (SAS) to determine significant differences among treatments. Treatment means were compared using Tukey test at the 0.05 probability level. Scores obtained from the quality evaluation of plants were analyzed through Mood's Median Test at the 0.05 probability level.

**Results and discussion**

1. **Plant height**

It was found that there were significant ($p<0.05$) differences in the plant height of Cordyline plants under different shade levels at 1, 2 and 3 months after transplanting (MAT).

Cordyline plants grown at 50% shade level (T2) showed maximum plant height (38.33cm) and lowest plant height (19.66 cm) was recorded in 80% shade level (T5) at 3 MAT (Fig. 1). At 80% of shade level plant would have received sub optimum level of light. This might be the reason for treatment. Plants recorded lower height lowest plant height observed in this

in control plants (open air) as well. Plants in the control treatment would have received excess irradiation above their requirement may have caused light stress on plants. Fini *et al.*, (2010) found that, lowest plant height was observed in open sunlight in the cultivation of *Camellia japonica* (Tea). Cordyline plants showed highest plant height at 50% of shade level (T2) at 1, 2 and 3 MAT. This may have been due to plants receiving optimum level of light intensity. Chen and Setter (2003) reported that shade significantly influenced cell division. Increased plant height could also be due to elongation of cells and increased number of cells due to higher rate of cell division under shade being a non-limited factor. These might be the reasons for highest plant height observed in this shade level throughout

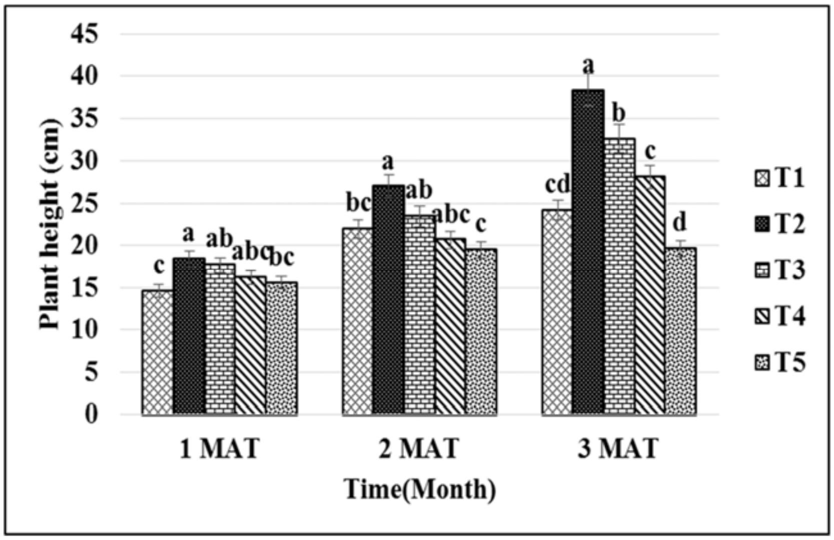


**Fig. 1.** Effect of different shade levels on the plant height of *C. fruticosa* var. 'Purple Compacta' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3).

the experiment. Moniruzzaman *et al*., (2009) reported the tallest plants were obtained from 50% shade level in the cultivation of *Bangladhonia* under different levels of shade (25%, 50%, 75, open sunlight).

**2. Leaf area pre plant**

In this experiment, there were significant ($p<0.05$) differences in the leaf area of Cordyline plants under different shade levels at 1, 2 and 3 months after transplanting (MAT). Cordyline plants grown at 80% shade level (T5) had lowest leaf area throughout the experiment. Plants grown under this shade level would have received lowest amount of light for photosynthesis. Thus development of vegetative growth was suppressed. Plants in the control treatment (open air) also produced lower leaf area. In this treatment, radiation might have been higher than the optimum requirement for Cordyline plants.

At higher irradiation levels, there may be chances for development of stress conditions in sensitive plants leaves. It was supported by Mattana *et al*., (2006).

Plants would have altered their morphological characters by reducing their leaf area to avoid stress conditions. Plants grown at 50% shade level (T2) showed highest leaf area.

This might be the fact that plant at this shade level would have received.

optimum amount of irradiation for their growth. This was evidenced by Marenco and Reis (1998), who found that leaf area was greater in wrinkled grass grown at 50% shade level than in those grown at control during the whole plant cycle.

**3. Plant biomass**

It was found that there were significant ($p<0.05$) differences in the plant biomass of Cordyline under different shade levels at 1, 2 and 3 months after transplanting (MAT).

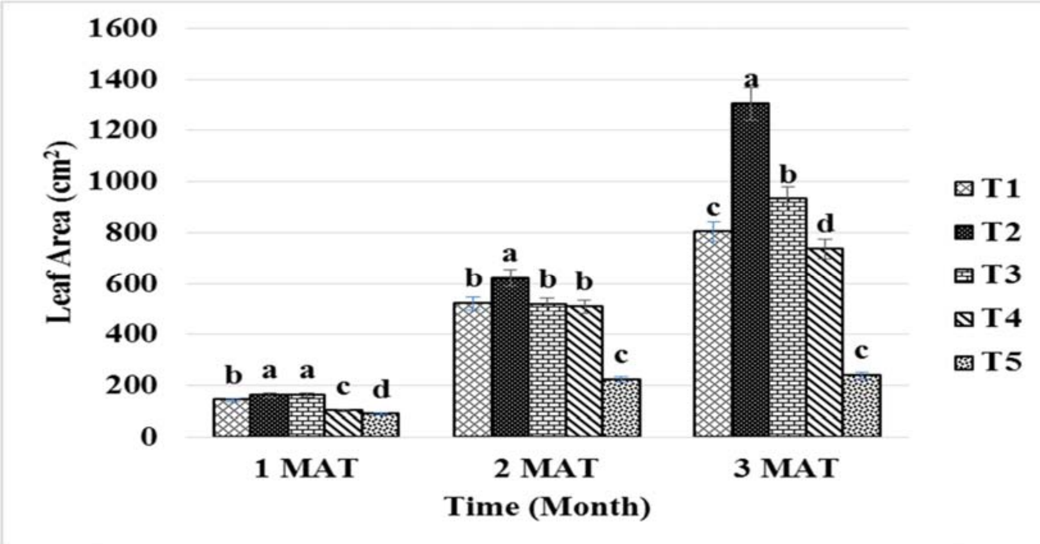


**Fig. 2.** Effect of different shade levels on the leaf area of *C. fruticosa* var. 'Purple Compacta' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3)

Cordyline plants grown at 80% shade level (T5) had lowest biomass at 3 MAT. Limitation in availability of light can reduce photosynthesis and subsequently biomass production. Cordyline plants grown at this shade level would have obtained sub optimum level of light. Therefore, lower biomass was obtained due to reduced rate of photosynthesis.

Cordyline plants showed significantly highest plant biomass at 50% of shade level (T2) at 1, 2 and 3 MAT. Plants grown at these shade level would have received optimum amount of shade. Therefore, their growth and carbon assimilation were at highest level. Leaf area of the plants was also higher at this shade level.

Increased leaf area contributes to enhanced photosynthesis and subsequently increased plant biomass. Dalirie *et al*., (2010) stated that, increasing leaf area index is one of the ways of increasing the capture of solar radiation within the canopy and production of dry matter. Phonguodume *et al*., (2010) revealed that *Xylia xylocarpa* and *Dipterocarpus alatus* plants accumulated higher plant biomass under 50-70% light intensity compared to other lighting conditions.

**Biomass partitioning**

It was found that there were significant ($p<0.05$) differences in the biomass partitioning of Cordyline plants under different shade levels at 3 months after transplanting(MAT). (Table 1)

Plants grown at 50% shade level had significantly highest biomass for root, shoot and leaf. At this shade level plants may have received optimum amount of light for their growth. This might be the reason for significantly highest biomass observed at 50% of shade. This coincided with findings of Sesma *et al.,* (2009). They stated that *Jatropha curcas*plants subjected to 50% shading showed greater growth than plants grown in full sun. Plants grown at 80% of shade obtained significantly lowest biomass for root, shoot and leaf.

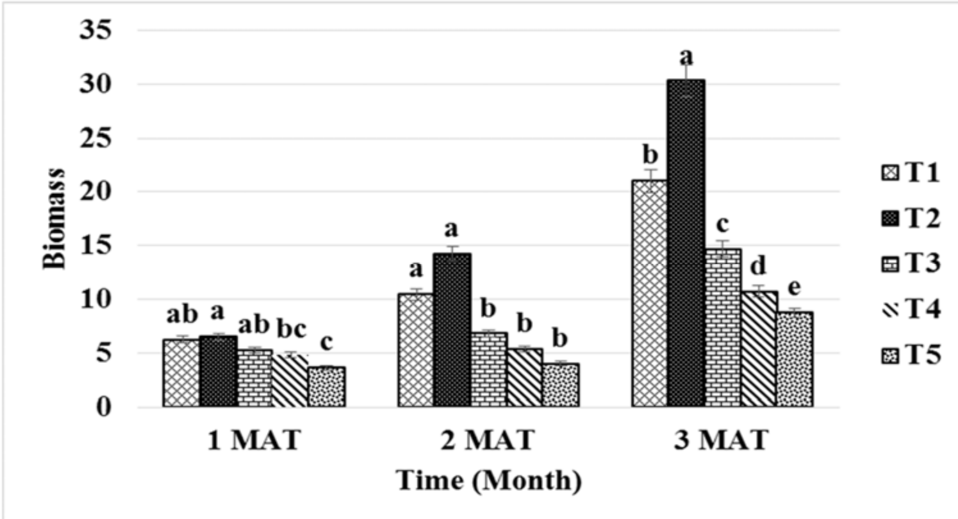


**Fig. 3**. Effect of different shade levels on the plant biomass of C. fruticosa var. 'Purple Compacta' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3)

**Table 1. Effect of different shade levels on biomass partitioning of *Cordyline fruticosa* var. 'Purple Compacta' at 3 months after transplanting**

| | **Biomass partitioning (g)** | | |
|---|---|---|---|
| **Shade level** | Root | Shoot | Leaves |
| **Control** | $9.37^{b}$ (51%) | $4.43^{c}$ (24%) | $4.73^{b}$ (25%) |
| **50%** | $11.86^{a}$ (36%) | $10.31^{a}$ (31%) | $10.567^{a}$ (33%) |
| **60%** | $3.07^{c}$ (22%) | $6.45^{b}$ (42%) | $5.16^{b}$ (36%) |
| **70%** | $1.57^{d}$ (14%) | $4.65^{c}$ (44%) | $4.51^{b}$ (42%) |
| **80%** | $0.59^{e}$ (10%) | $3.86^{c}$ (67%) | $1.28^{c}$ (23%) |

Means (n=3) within the same column followed by the same letter are not significant at $p < 0.05$ value in parentheses are percentage value for biomass partitioning.

Plants grown at this shade level would have received lowest radiation. It subsequently reduced the photosynthesis process. It revealed that plants in 80% shade were subjected to low light stress. Plants competing for light will shift biomass partitioning toward more leaf and shoot production and less root production.

Allocation of biomass for root was highest (56%) in control (T1). Plants grown at open field condition were subjected to water stress as they allocated more resources for root development. Plants allocate biomass to the organ that acquires the most limiting resource (Bloom *et al*., 1985). According to the optimal partitioning theory plants will respond to changes in the environment by shifting biomass partitioning patterns to obtain the most limiting resource (Hilbert, 1990). Highest (67%) shoot biomass partitioning was observed in plants grown at 80% shade level. Plants grown at 80% of shade level would have received low amount of irradiation. According to the optimum partitioning theory, allocation of biomass

for shoot was higher to receive more amount of radiation at 80 % shade level. Allocation of biomass for leaf was highest (42%) in 70% of shade level. Plants at this shade level would have received sub optimum level of light. It revealed that

plants in 70% shade level were subjected to low light stress. As per optimal partitioning theory, plants competing for light will shift more biomass towards leaf production. Cordyline plants grown at 50% of shade level would have received optimum light for better growth. At this shade level, the biomass allocation for different organs was higher and almost equal.

**5. Quality of plant**

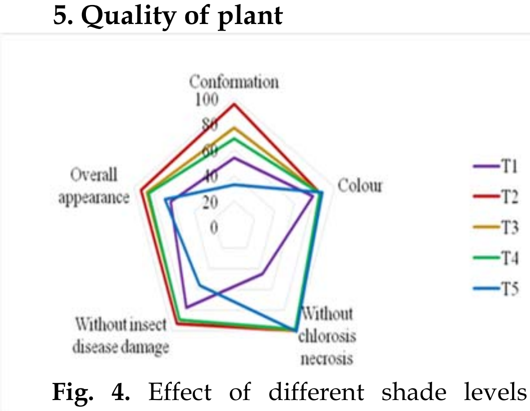


**Fig. 4.** Effect of different shade levels on quality of *Cordyline fruticosa* var. 'Purple Compacta' at 3 MAT

open field condition (Fig.4). Chlorophyll is the major component that influences colour of the foliage. Amount of chlorophyll in the plants is influenced by amount of light received by the plants. Plants under control condition would have received a higher amount of light than their requirement. Therefore, low amount of chlorophyll was produced by plants in this treatment. However, in shade treatments there might have been limitations of irradiation for photosynthesis. The amount of chlorophyll could be increased in foliage to trap available light as much possible. This may have caused increased colour of foliage in plants belong to shade treatments. This may be the possible reason for the increased colouration of plants in shade treatments. Prasad and Kumar, (2003) stated that light level is a very important factor, because it influences the chloroplast development in leaves during the growth thereby influence leaf colour and variegation.

Plants in the control treatment had highest chlorosis and necrosis while lowest was observed in shade conditions. It may be due to highest amount of light received by the plants at outdoors under full sun light (open field). High light levels caused damage to chlorophyll and resulted in burned appearance of plants. Solar radiation could be beneficial to plant growth, but the extreme could be harmful (Teremura, 1983).

Plant grown under 50% of shade level (T2) obtained remarkable confirmation and greatest overall appearance than plants belong to other treatments. Plants under this shad level would have received optimum amount of light for better quality characters. These results are in agreement with Gaurav *et al*., (2015). They revealed that when Cordyline was cultivated under different shade level (35%, 50, 75%, 90% and control), 50% shading intensity produced plants with better morphological characters and foliage quality.

## Conclusions

In this experiment, *Cordyline fruticosa* variety 'Purple Compacta' plants performed better under 50 % of shade level. Plants attained higher plant height, leaf area, plant biomass and biomass partitioning at 50% shade level. Quality assessment indicated that plants grown at 50% shade had highest mean score. Higher (open field) and lower irradiation (80% of shade level) negatively influenced on Cordyline plant growth and quality. *C. fruticosa* variety 'Purple Compacta' plants would have received optimum amount of light at 50 % shade level for better performance. It could be the reason for highest performance of these plants at this shade level. From this study, it may be concluded that, 50% shade level is suitable for growing Cordyline in the Batticaloa district of Sri Lanka.

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