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Growth and quality Reponses of Polycias (*Polyscias balfouriana* L. var. 'Marginata') to different levels of shade

Rajendran Thanusha[1], Shanmugalingam Srikrishnah[2*], Somasundaram Sutharsan[3]
[1-3]Department of Crop Science, Faculty of Agriculture, Eastern University, Sri Lanka

Abstractp
Polyscias balfouriana L. var. 'Marginata' is an ornamental foliage shrub with glossy green coloured leaves with white margins. Export quality of polycias is influenced by the morphology of the leaves. Light intensity has great influence on the leaf morphology and variegation in polycias plants. An experiment was conducted in the Crop farm, Eastern University, Sri Lanka with the objective of assessing the resposes of the *Polyscias balfouriana* L. var. 'Marginata' to different shade levels. Five treatments were defined in the experiment as T1: open field cultivation, T2: 50%, T3: 60%, T4: 70% and T5: 80% shade levels. The experimental design was a completely randomized design (CRD) with three replications. Uniform agronomic practices were followed for all plants in different treatments. Growth measurements *viz*. plant height, leaf area per plant and plant biomass were measured at monthly intervals. Quality standards of cuttings were assessed at the final stage of the experiment. Analysis of variance was carried out to determine the effect of treatments on measured parameters and treatment means were separated by Tukey test ($p< 0.05$). Results revealed that, plants grown at 50% shade level showed significantly ($p<0.05$) highest performance in measured growth parameters. However, lowest performance was recorded in plants grown at 80% shade level and open field condition. In quality evaluation, plants grown at 50% shade level received significantly highest score as well. Therefore, it could be concluded that 50% shade is optimum for growing *Polyscias balfouriana* L. var. 'Marginata' in the Batticaloa district of Sri Lanka.

Keywords: shade levels, plant height, leaf area, plant biomass

1. Introduction
Polyscias balfouriana is a popular foliage plant belongs to family Araliaceae [1]. This plant is an ornamental foliage shrub with glossy green coloured leaves with white margins. P. balfouriana consists of many varieties and var. "Marginata" is a popular foliage plant in the world floriculture industry. *Polyscias balfouriana* L. var. 'Marginata' (PBM) is widely used in landscaping and as a potted ornamental plant [2]. The morphology of the leaves provides value for its quality in the export market [3]. Sri Lanka has three agro ecological zones and among them, dry zone consists of a larger area. Therefore the introduction of floricultural crops could be an important intervention in this regard. The climatic requirements of PBM is well-suited with prevailing climatic conditions of the Batticaloa district. Polycias is tropical foliage prefer high temperature and humidity. Commercial nurseries could be established in the Batticaloa district to cater the foreign demand for polycias cuttings. This venture could act as a foreign income generator to the district. Polycias is a shade obligate plant and partial shade is recommended for the cultivation in Sri Lanka. However, there is no studies carried out to identify the optimal light intensity for PBM in the Batticaloa district. Light level is a vital ecological factor influences the cultivation of plants [4]. Shade manipulates the growth and quality of ornamental foliage plants. However, there is no site specific recommendation for shade level. Hence the present study was conducted to find the optimum shade level of *Polyscias balfouriana* L. var. 'Marginata' (PBM) in the Batticaloa district.

2. Materials and Methods
This experiment was performed at the crop farm, Eastern University, Vantharumoolai (7.7944° N, 81.5790° E), Batticaloa (agro-ecological zone DL2), Sri Lanka. Treatments were defined as T1: open field cultivation, T2: 50%, T3: 60%, T4: 70% and T5: 80% shade levels. The experimental design was a completely randomized design. Each treatment contained thirty plants and an experimental unit consisted of one plant. Uniform, rooted and one month old cuttings were obtained from Tropical Abundance (Pvt) Ltd, Giriulla. Before planting the cuttings were treated with a fungicide (Captan®) to avoid infections. The cuttings were planted in polybags (30cm diameter and 30cm height) filled with a potting medium consisting of 4: 2: 1: 1 volume basis ratio of loamy soil, compost, cattle manure, and sand. Experimental plants were arranged in a way to occupy the spacing of 30 plants per m^2. Irrigation of plants was carried out according to the moisture level of plants in different shade levels and other management practices were followed uniformly according to the recommendation. Destructive sampling was practiced. Plants were sampled in monthly interval in all treatments during the experiment. The measurements made were plant height, leaf area per plant (Leaf area meter, Li-Cor Inc.) and plant biomass (Oven dry method) at monthly intervals. Quality evaluation was done at the end of the experiment. Analysis of variance was carried out to find out the effect of treatments on measured parameters and treatment means were separated by Tukey test ($p< 0.05$). Treatment means were separated by Tukey test at 0.05 probability level. Mood's Median test at the 0.05 probability level was used to analyze the scores from the

quality evaluation of plants.

3. Results and Discussion

3.1 Plant height

Different shade levels influenced the plant height of *Polyscias balfouriana* L. var. 'Marginata' significantly ($p<0.05$) (Fig.1). Plant height was significantly ($p<0.05$) higher in treatment 2 (T2) compared with other treatments at 1, 2 and 3 months after transplanting (MAT).

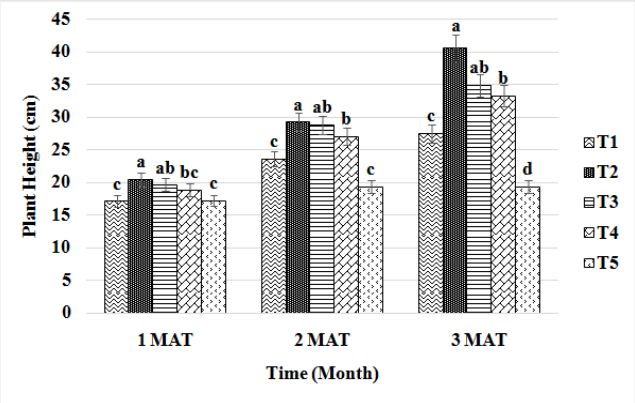

Fig 1: Plant height of the *Polyscias balfouriana* L. var. 'Marginata' under different shade levels at 1, 2 and 3 months after planting (MAT). Means followed by same letter within a month are not significantly different with the Tukey test at 5% level of probability. (n=3)

At 3 MAT, Plants grown in 80% shading had the lowest plant height (19.333 cm) among all the treatments, while the highest plant height (40.633 cm) was recorded on plants provided with 50% shading.The lowest plant height and reduced growth rate were observed in 80% shade level (T5) throughout the experiment compare with other treatments. In higher shade levels, the radiation received by the plants might be lower than their requirement. Villegas *et al*. [5] reported that higher shading reduced plant height in Cyclamen persicum. Plants grown in open field conditions (T1) also produced lower plant height. There might be possibilities for the destruction of photosynthetic pigments in sensitive plants at higher irradiation levels. Mattana *et al*. [4] reported that, higher irradiance level in esciophyte plants, like Pothomorpheum bellata, can cause photo-degradation of cromopigments, with decreases in photosynthesis and, consequently, biomass. The degradation of the photosynthetic pigments probably was responsible for the decrease in photosynthesis and subsequent growth. PBM plants are shade obligate and might be sensitive to higher irradiation levels. It could be the reason for reduction of plant height at open field conditions.PBM plants showed highest plant height in shade level of 50% (T2) followed by in 60%(T3) and 70%(T4) at 1, 2 and 3 MAT. It indicates that increasing shade level cause reduce in plant height. Chen *et al*. (2003) [6]. Reported that, increases in number and length of internodes results in a progressive increase in plant height. The highest plant height was obtained in 50% shade level (T2). In this experiment, optimum shade level would have been received by the plants grown at 50% shade. Optimum light level is an essential factor for maximum photosynthesis. It could be the reason the highest plant height recorded at this shade level. From these findings, it could be stated that the plant height of PBM was significantly influenced by different shade levels and 50% shade level was more suitable for the growth of PBM plants in the Batticaloa district.

3.2 Leaf area per plant

Different shade levels influenced the leaf area of PBM plants significantly ($p<0.05$) (Figure 2). Leaf area was significantly ($p<0.05$) higher in T4 (70% shade) than other treatments at 1, 2 and 3 months after transplanting (MAT).

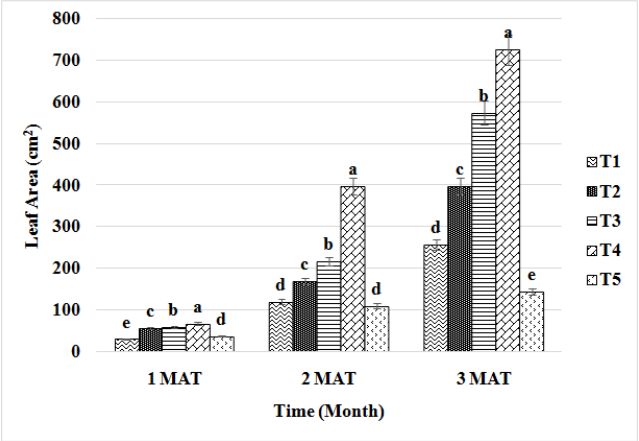

Fig 2: Leaf area of the *Polyscias balfouriana* "Marginata" under different shade levels at 1, 2 and 3 months after planting (MAT). Means followed by same letter within a monthare not significantly different with the Tukey test at 5% level of probability. (n=3).

Plants grown in 80% shade had the lowest leaf area (144.87 cm^2) among all the treatments, while the highest leaf area (725.6 cm^2) was recorded in plants provided with 70% shading at 3 MAT. Shading influences the leaf area. Leaves are vital for photosynthesis. They perform a vital role in survival and growth of a plant. Leaf area is a feature that is used to analyse the shade affected of different species because it correlates directly with the photosynthetic surface area [7]. The lowest leaf area was observed in 80% shade level (T5) compare with other treatments throughout the experiment. In 80% shade level, development of LA was significantly reduced in PBM plants as radiation received by the plants was lower than their requirement. Plants grown in open field conditions (T1) also produced lower leaf area. All plants need sunlight for their survival. However, in general, more sunlight does not always make it easier for plants to survive. In direct sunlight, plants face desiccation and exposure to higher light than their requirement. PBM plants showed highest leaf area in shade level of 70% followed by in 60%, 50%, 80% at 1, 2, 3 MAT. It showed that 70% shade provided required amount of light for optimum growth of PBM plants. These could be the possible reasons for highest leaf area of plants grown at 70 % shade level. Beard [8] reported that the morphological changes of turf grasses grown under shade conditions include increases in leaf length, leaf area and leaf thickness. Kittas *et al*. [9] (2008) reported that shaded peppers have increased internodes, bigger leaves and higher leaf area per plant.

3.3 Plant biomass

The plant biomass was significantly ($p<0.05$) influenced by different shade levels (Fig. 3) and it was significantly ($p<0.05$) higher in treatment 2 (50 % shade level) compared with other treatments at 1, 2 and 3 months after transplanting (MAT).

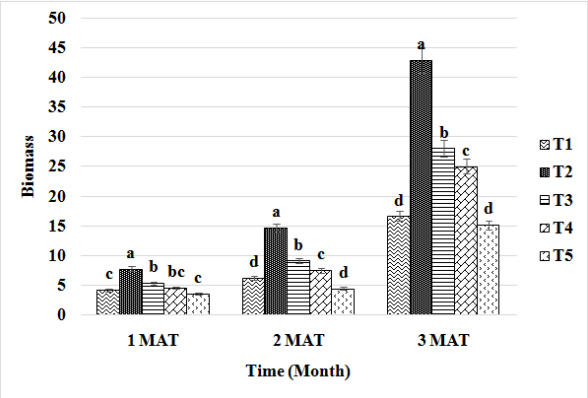

Fig 3: Total Biomass of the *Polyscias balfouriana* "Marginata" under different shade levels at 1, 2 and 3 months after transplanting (MAT). Means followed by same letter within a month are not significantly different with the Tukey test at 5% level of probability. (n=3)

Plants grown in 80% shading (T5) and open field (T1) produced significantly lowest biomass (15.14 g) though the highest biomass (42.892 g) was recorded in plants grown at 50% shading at 3 MAT. Shading affects the plant biomass of plant. Biomass is a measure of plant productivity. Plant dry matter accumulation affected by leaf area of the plant [10]. PBM plants grown at 80% shade level (T5) produced significantly ($p<0.05$) lowest biomass than other treatments throughout the experiment. Dry matter accumulation was significantly reduced by the higher levels of shading. The results showed that plants grown under open field conditions (T1) also produced lower plant biomass. Similar results were found by Silva *et al*. [11]. They reported that the biomass increased significantly with the increase in radiation level. However, different plants have different optimum light requirements and both deficient and excessive light intensities are injurious [12]. Mattana *et al*. [4] reported that, higher irradiance levels in plants can cause photo degradation of chromo pigments, with a decrease in photosynthesis causing in a decrease in the biomass yield. Polyscias might be sensitive to higher irradiation levels, which would have caused degradation of photosynthetic pigments and subsequent reduction of growth. This might be the reason for reduction of biomass in plants grown at open field (T1). Significantly highest biomass was recorded at 50% (T2) shade level followed by in 60% (T3) and 70%(T4) at 1,2,3 MAT. It indicates that increasing shade level cause a reduction in plant total biomass. This result was line with the findings of Popma and Bongers [13], who reported that biomass decrease with an increase of the level of shading. Plants grown under 50% shade would have received optimum light for maximum growth. Therefore, their growth rate and carbon assimilation were at highest level. This might be the reason for the highest biomass produced by the plants in these shade level. Semchenko *et al*. [14] stated that, moderate shade had a strongly facilitative effect on plant growth. Marenco *et al*. [15], reported that in Ischaemum rugosum plants grown at 50% shading accumulated greater amount of dry matter than plants in full sun

3.4 Quality of experimental plants

The Quality of plants was significantly (Mood's Median test, p= 0.00) influenced by different shade levels (Table 4.5) and it was significantly (p = 0.00) higher in treatment 2 (50 % shade level) compared with other treatments at 3 months after transplanting (MAT).

Table 1: Quality analysis of Polyscias at 3 months after planting

Shade level (%)	Median
Control	31.5
50%	85.5
60%	81.5
70%	67.0
80%	39.0
P value	0.00

(n=10)

Terminal cuttings are main products from the polycias nurseries in Sri Lanka to the export market. Quality of cuttings plays a major role in the price per cuttings and sustainability in demand. Noordegraaf [16] opined that colour of leaves, expansion of leaf, elongation of the shoot, number of leaves in a cutting are the primary parameters for the quality of foliage plants. In the quality evaluation, PBM plants grown at 50% shade level (T2) received significantly highest median (85.5) while significantly lowest median (31.5) was received by plants grown at open field condition (T1) plant. Findings of this experiment revealed that plants grown at 50 % of shade level would have received optimum amount of light intensity. Light intensity is an important factor influence the quality of foliage and optimum light level maximizes the quality of shade obligate ornamental plants *viz*. polycias. Therefore, plants grown at 50% (T2) shade level obtained highest score in the quality evaluation.

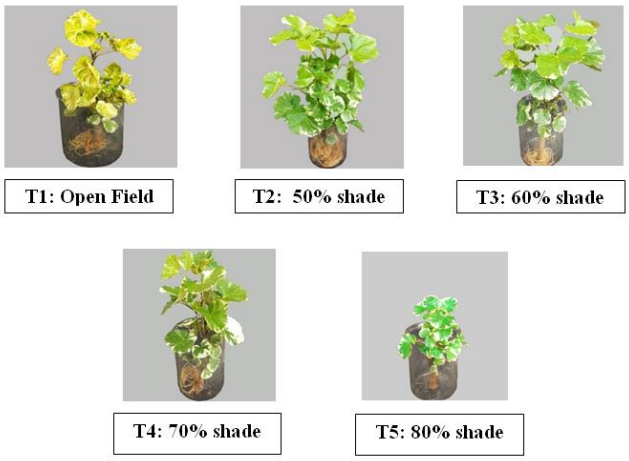

Fig 4: Polyscias plants under different shade levels at

3 MAP

Plants grown at the open field condition would have received an surplus amount of irradiation beyond their requirement. Mattana *et al*., (2006) [4] revealed that higher irradiance level in shade obligate plants might cause destruction of cromo-pigments. The destruction of pigments mught cause reduction of quality in ornamental plants. It might be the reason for the low quality of plants obtained in control treatment. In this experiment, plants grown at control produced pale green colour foliage when compared to another treatment. As per the statement of Ballantine and Forde [17], plants have lower chlorophyll content at a higher light level. It was observed that plants under 50% shade level had virtuous confirmation and superior overall

appearance than other treatments. This may be due to plants under this shade level received an optimum amount of irradiation thus make the improved quality of plants. From the findings, it could be stated that variation in shade levels influences quality of p olycias. Highest quality plants were produced at 50% shade level in this experiment. Hence, 50% level of shade is most suitable for growing polycias in the Batticaloa district.

4. Conclusion

This experiment revealed several facts. *Polyscias balfouriana* var. 'Marginata' plants are responsive to different shade levels. Better growth and quality was observed in plants grown at 50% shade level. Highest plant height and biomass were recorded at this shade level. In quality evaluation, plants grown at 50% shade level received significantly highest score. Lowest growth and quality were observed in plants grown at 80 shade level and open field conditions. Findings of this experiment revealed that 50% shade level is suitable for the cultivation of *Polyscias balfouriana* var. 'Marginata' in the District of Batticaloa in Sri Lanka.

5. References

1. Sandhya S, Vinod KR, Diwakar CM, Kumar NR. Evaluation of antiulcer activity of root and leaf extract of *Polyscias balfouriana* var. Marginata. Journal of Chemical and Pharmaceutical Research. 2010; 2(1):192-195.
2. Bose TK, Chowdhury B. Tropical Garden Plants in Colour. Horticulture and Allied Publishers, Calcutta, India, 1991.
3. Gunadasa HKSG, Dissanayake PK. Optimization of quality in exported *Polyscias balfouriana* "marginata" by using different shade levels. Journal of Agricultural Sciences. 2012; 7(2):58-65.
4. Mattana RS, Ming LC, Marchese JA, Marques MOM. Biomass production in plants of Pothomorphe umbellata (L.)Miq. submitted to different shade levels. 2006; 8:83-85. Revista Brasileira de Plantas Medicinais.
5. Villegas E, Pérez M, Lao MT. Influence of lighting levels by shading cloths on Cyclamen persicum quality. Acta Horticultura.2006; 711:145-150.
6. Chen CT, Setter TL. Response of potato tuber cell division and growth to shade and elevated CO_2. 2003; 91(3):373-381. Annals of Botany..
7. Farias VC, Silva DE, Almeida AJ. Análise de crescimento de mudas de cedrorana (Cedrelinga catenaeformis(Ducke) Ducke) cultivadasemcondições de viveiro. Revista Brasileira de Sementes. 1997; 19(2):193-200.
8. Beard JB. Shade stresses and adaptation mechanisms of turfgrasses. International Turf grass Society Research Journal. 1997; 8(2):1186-1195.
9. Kittas C, Rigakis N, Katsoulas, N, Bartzanas, T. Influence of shading screens on microclimate, growth and productivity of tomato. International Symposium on Strategies towards Sustainability of Protected Cultivation in Mild Winter Climate 807, 2008, 97-102.
10. Dalirie MS, Sharifi RS, Farzaneh S. Evaluation of yield, dry matter accumulation and leaf area index in wheat genotypes as affected by terminal drought stress. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2010; 38(1):182-186.
11. Silva FG, Pinto JEBP, Cardoso MDG, Nascimento EA, Nelson DL, Sales JDF. *et al*. Influence of radiation level on plant growth, yield and quality of essential oil in carqueja. Ciência e Agrotecnologia. 2006; 30(1):52-57.
12. Manaker GH. Interior plantscapes. Installation, Maintenance and Management, 1981.
13. Popma J, Bongers F. The effect of canopy gaps on growth and morphology of seedlings of rain forest species. Oecologia. 1988; 75(4):625-632.
14. Semchenko M, Lepik M, Götzenberger L, Zobel K. Positive effect of shade on plant growth: amelioration of stress or active regulation of growth rate?. Journal of Ecology. 2012; 100(2):459-466.
15. Marenco RA, Reis AC. Shading as an environmental factor affecting the growth of Ischaemum rugosum. Brazilian Journal of Plant Physiology. 1998; 10(2):107-112.
16. Noordegraaf C. Production and Marketing of High Quality Plants. International Work shop on Floriculture and Nursery Industries and Environment. Acta Horticultura, 1992, 353.
17. Ballantine JEM, Forde BJ. 1970. The effect of light intensity and temperature on plant growth and chloroplast ultrastructure in soybean. American Journal of Botany. 1970; 57(10):1150-1159.