Available online at www.ijrp.org

IJRP.ORG
International Journal of Research Publications

International Journal of Research Publications

Influence of Different Shade Levels on the Growth and Quality of *Polyscias guilfoylei* 'variegata' in the Batticaloa District of Sri Lanka

Narmhikaa,K.*, Srikrishnah, S., Sutharsan,S. and Mayoory,J.

Department of Crop Science, Faculty of Agriculture, Eastern University, Vantharumoolai, Chenkalady, 30350 ,SriLanka.
k.narmhikaa91@gmail.com.

Abstract

Polyscias guilfoylei 'variegata'is an beautifully variegated ornamental foliage shrub having lush green leaves with large irregular patches of ochre yellow from the midvein to the edges. The morphology of the leaves adds value for its quality in the export market. Light intensity greatly influences the amount of variegation in these plants. A shade house experimentation was carried out to estimate the effects of graded shade levels on the growth and quality of *Polyscias guilfoylei* 'variegata', in the Batticaloa district of Sri Lanka from July 2017 to November 2017. The experiment was arranged in a completely randomized design with three replications. The experimental location was crop farm, Eastern University, Sri Lanka. Graded shade levels were defined as treatments viz. Control (T1), 50% (T2), 60% (T3), 70% (T4), and 80% (T5), of shade levels. Shade houses were constructed using commercial nylon nets of different shade level. Rooted, uniform cuttings of were used as planting materials. Agronomic practices were followed uniformly for all treatments. Plant height, leaf area, number of leaves , plant biomass and SPAD value were measured at monthly interval

and quality of cuttings was evaluated at the end of experiment. Analysis of Variance was performed to determine significant difference among treatments ($p< 0.05$). Plants provided with 50% shading showed significantly ($p<0.05$) better performance in measured growth parameters viz. plant height, plant biomass and biomass partitioning, while the lowest performance was observed in plants from 80% (T5) shading (lower irradiation) and open field (higher irradiation) condition (T1) . Results revealed that, plants provided with 70% shade level showed significantly ($p<0.05$) better performance in measured growth parameters. In quality assessment also, plants grown at 70% shade level (T4) received significantly highest score. : Therefore, it could be concluded that, 70% shade level is optimum for the export oriented cultivation of *Polyscias guilfoylei* 'variegata' in the Batticaloa district of Sri Lanka. This is beneficial to the farmers who are engaged in the floriculture cultivation in Batticaloa district of Sri Lanka. They can improve the quality of the plants by providing 70% shade level. It leads to improve their economic savings and market demand.

Keywords: Plant height; Shade level; Biomass; Leaf thickness; SPAD value; Leaf area

1. Introduction

Foliage ornamentals and cut flowers play vital role in the floricultural industry of Sri Lanka. Floriculture industry of Sri Lanka has developed to provide consistent supply of quality floriculture products across the world[1]. Floriculture products are widely used in decoration as a-filler in floral compositions and provide freshness, colour and variety to arrangements and bouquets[2]. In addition to that, agro climatic condition of Sri Lanka is highly favorable to growing foliage ornamental and cut flowers[3].

Polyscias guilfoylei 'variegata' an ornamental foliage is a member of family Araliaceae. It is a perennial crop, extensively used in landscaping. Lush green leaves of this variety are beautifully variegated with large irregular patches of ochre yellow from the mid vein to the edges. Therefore, it has high demand in the export market due to the attractive morphological features of the plant[4]. Climatic conditions of dry zone are suitable

to growing tropic growing tropical flowers and foliage ornamentals under appropriate conditions[5]. Batticaloa is an important agricultural district in the dry zone of Sri Lanka[6].

Improvement of floricultural industry in Batticaloa district would furnish several benefits to the farming society. It will lead improvement of famers' livelihood and women employment as well as contribute to national economy. Since *Polyscias guilfoylei* 'variegata' is a tropical shade loving plant, it is essential to find the optimum shade level for maximum quality of the plant. Because irradiance level is one of the major environmental factors that influence the biomass, leaf area, quality, chlorophyll and plant growth[7]. Providing required amount of shade condition will enhance the quality of ornamental plants [8]. Therefore scientific studies are needed to find the optimum shade condition for the cultivation of *Polyscias guilfoylei* 'variegata' in the Batticaloa district. Hence the objective of the study is to evaluate the effects of graded shade levels on the growth and quality of *Polyscias guilfoylei* 'variegata' in Batticaloa district of Sri Lanka.

2. Materials and Methodology

Experimental Site: A shade house experiment was conducted from July 2017 to November 2017 at the crop farm, Eastern University, Batticaloa (7.7944° N, 81.5790° E ecological zone DL2), Sri Lanka.

Treatments, experimental design and plot size: Experiment was arranged in a completely randomized design (CRD) and each treatment contained 20 replicates. Graded levels of shade were defined as treatments viz. Open sunlight (T1) (as control), 50% (T2), 60% (T3), 70% (T4), and 80% (T5). Uniform, rooted and a month old cuttings of *Polyscias guilfoylei* 'variegata were collected from a private nursery. The cutting were planted in black poly bags (13cm diameter, 17.5cm height) filled with a potting medium top soil and compost in a ratio of 1: 1 (volume basis). Plants were arranged at a spacing of 20 plants per m^2.

Measurement and Data gathering: Samples were collected randomly from each treatment. Plant height (cm), leaf area, plant biomass (g), biomass partitioning (%) and SPAD value were taken at monthly interval.

Quality evaluation of experimental plants was done at Crop Science Laboratory by expert panellist. Criteria used for evaluation suggested by Conover and Poole[9].

Statistical Analysis: 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

3. Results and Discussion

Leaf area(cm^2):

It was observed that there were significant ($p<0.05$) differences among the treatments in leaf area per plant (Figure 1). Leaf area was significantly ($p<0.05$) higher in treatment 4 (T4) compared with other treatments at 1, 2 and 3 months after transplanting (MAT).

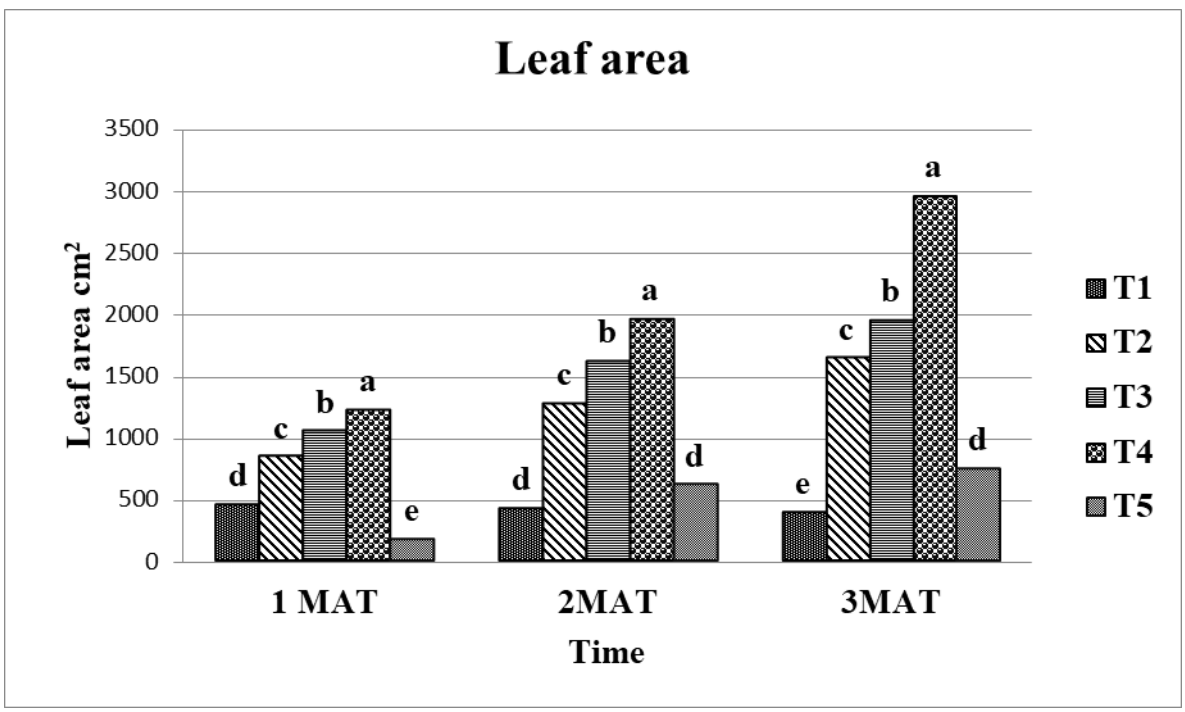

Figure 1: Effect of different shade levels on the plant leaf area of *Polyscias guilfoylei* 'variegata' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different

according to the Tukey test at 5% level of probability. (n=3)

Different shade levels significantly ($p<0.05$) influenced the leaf area of *Polyscias guilfoylei* 'variegata' plants at 1, 2 and 3 months (MAT) after transplanting (Figure 1). Highest leaf area was recorded in plants provided with 70% shading at 3 month while lowest leaf area was observed in open field. Plants which were grown under 80% shade level also produced lowest leaf area throughout the experiment. In this study, the *Polyscias guilfoylei* 'variegata' performed better under 50% and 70% shade levels. Plant height was higher at 50% shade level and other parameters were higher at 70% shade level.

The proportion of solar radiation incident on plant has an impact on plant growth [10]. Leaf which is exposed to plenty of light has sufficient amounts of food and won't need an extreme amount of chlorophyll[11]. This enables the leaf to have a small surface area. This might be the reason for the low leaf area of plants which were grown under open field. Lowest leaf area was observed at 80% shade level throughout the experiment. Inadequate amount of solar radiation suppresses the growth of plant. At 80% shade level plant may unable to receive the sufficient amount of solar radiation to activate photosynthesis process and crop growth. Ultimately it leads to produce leaves with low area at 80% of shade. Lowest leaf area was observed at 80% shade level in *Cordyline fruiticosa* variety 'Purple Compacta' [6].

Results indicate that, highest leaf area was observed at 70% shade level. This is proved that 70% shade provided ideal amount of irradiation interception for optimum growth of *Polyscias guilfoylei* 'variegata' plants. Shaded peppers have longer internodes, larger leaves, greater whole-plant leaf area, and thinner leaves at 70% of shade [12]. Dracaena plants grown at 50% and 70% shade level showed higher leaf area than the plants at 80% shade. Plants were showed higher leaf area under 75% of shade level in *Cordyline terminalis* [2]

Plant Height (cm) :

Different shade levels influenced the plant height of *Polyscias guilfoylei* 'variegata' significantly ($p<0.05$) (Figure 2). 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).

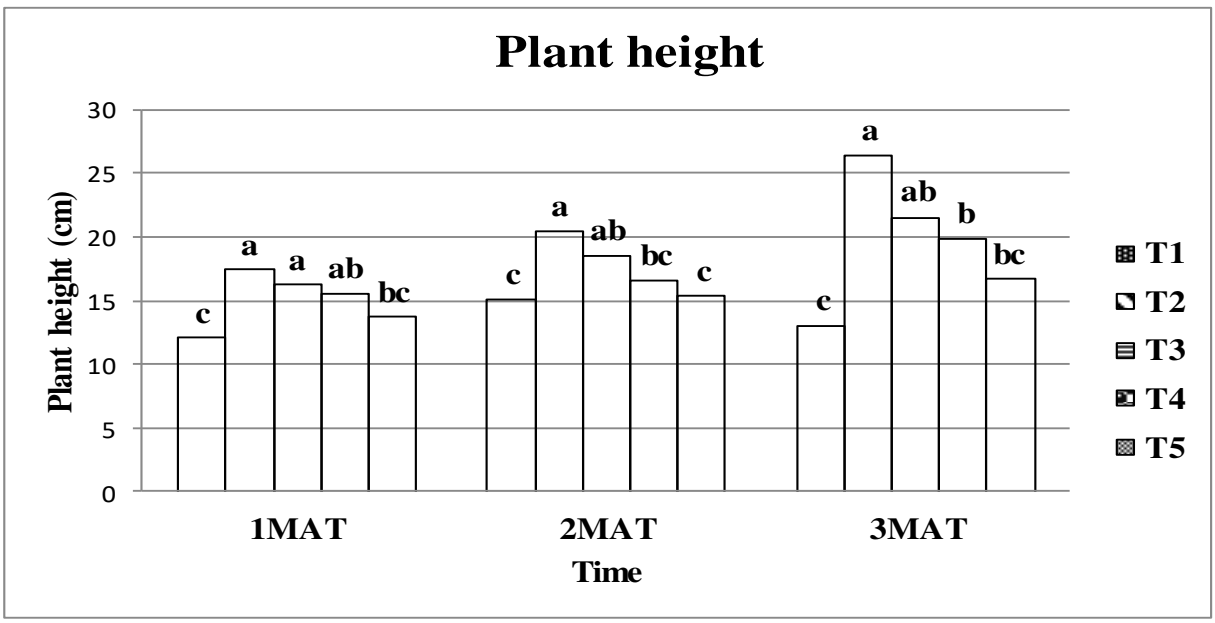

Figure 2: Effect of different shade levels on the plant height of *Polyscias guilfoylei* 'variegata' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3).

It was found that there were significant ($p<0.05$) differences in the plant height of *Polyscias guilfoylei* 'variegata' under different shade levels at 1, 2 and 3 MAT after transplanting (Figure 2). Highest plants height (26 cm) was recorded on plants provided with 50% shading whereas, lowest plant height was recorded on plants in open field (T1). Solar radiation is one of the essential environmental factors for plant growth. But excess quantity of solar radiation interception alters the photosynthetic process, impose light stress on plant

and suppress the plant growth [13].Therefore in open field plants would have received excess amount of radiation than their requirement. It might be the reason for lowest height of plants grown under open field.

The plants at 80% shade level also showed lowest plant height. Plants grown at 80% shade level would have received lesser amount of solar radiation. Higher shade level restricts the quantity of irradiance interception which is necessary for physiological process such as growth and photosynthesis[14]. Higher shading affected the plant height in *Cyclamen persicum* due the reduction of photosynthetic activity [15]. In this study, highest plant height was recorded in 50% shade level. Maximum plant height was recorded at 50% shade level in *Cordyline terminalis* [2]. But maximum plant height at 70% shade level in carnation plant [16].

Biomass (g):

The plant biomass was significantly ($p<0.05$) influenced by different shade levels (Figure 3) and it was significantly ($p<0.05$) higher in treatment 4 (70 % shade level) compared with other treatments at 1, 2 and 3 months after transplanting (MAT).

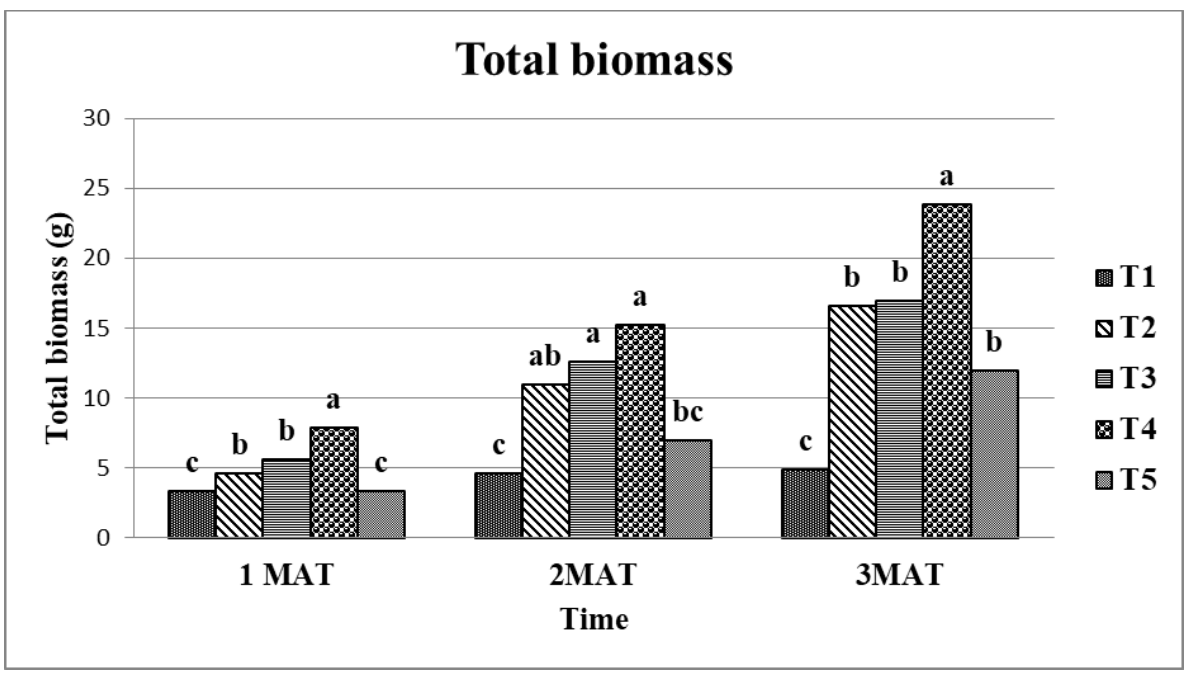

Figure 3: Effect of different shade levels on the plant biomass of *Polyscias guilfoylei* 'variegata' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3).

Result showed that, there were significant ($p<0.05$) difference in biomass of *Polyscias guilfoylei* 'variegata' plants at 1. 2 and 3 months after transplanting (Figure 3). Lowest plant biomass was recorded in open field while plants under 70% was obtained highest plant biomass. *Polyscias guilfoylei* 'variegata' plants belong to open field produced significantly ($p<0.05$) lowest plant biomass while plants under 70% obtained highest plant biomass. *Polyscias guilfoylei* 'variegata' is a shade loving plant and could be high sensitive to irradiation. Increase irradiation level decrease the photosynthetic process through the photo destruction of chromo pigments[11]. Hence this might be the reason for lowest biomass on plants at open field.

Leaf area also influences the production of biomass. High leaf area will produce high biomass in plants. Because high interception of solar radiation by the leaf causes to increase dry matter accumulation[17].Therefore plants under 80% shade level produced lowest biomass. In this study, highest leaf area was observed in plants grown at 70% shade level. This could be the reason for highest biomass in plants at 70% shade level. Dracaena grown at 70% shade level produced highest biomass and lowest obtained at 80% shade level [5].

SPAD value:

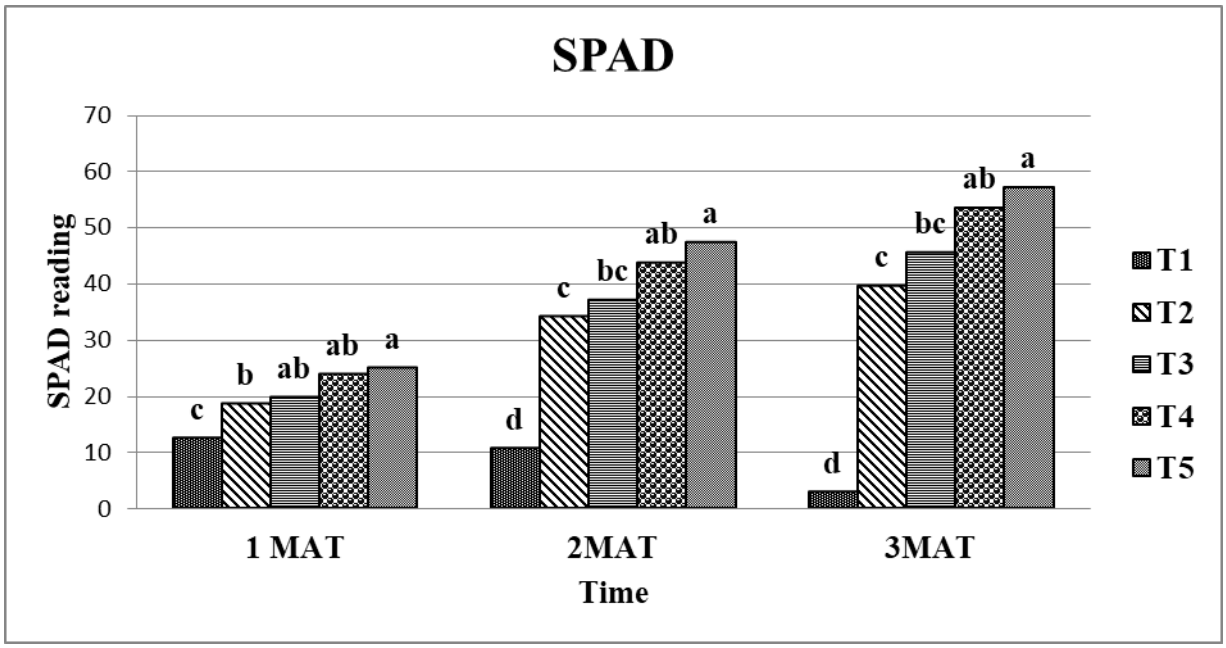

Figure 4: Effect of different shade levels on the SPAD value of *Polyscias guilfoylei* 'variegata' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3)

SPAD meter (Model: SPAD 502, Minolta crop, Ramsey, NJ) was used to determine the relative amount of chlorophyll present by measuring the absorbance of the leaf in two wavelength regions (650 and 940). Increasing SPAD values indicate higher concentrations of Chlorophyll per leaf unit area. SPAD reading was found to be higher in plants grown under 80% shade level, whereas lowest value was recorded on plants grown at open field (4) (Figure 4). SPAD measurement was higher under 80% shade level (57.3) while, lowest value was recorded on open filed plants. SPAD reading was found to be higher under 50% shade (47.81) and 90% shade (43%) compare to control [2]. In agreement with the present studies, *Centella asiatica* was showed higher SPAD reading at 70% shade level [18]. Shade nets were used to increase chlorophyll production in Compact Gardenia (*Gardenia jasminoides* Ellis) Potted Plant[19]. Chlorophyll content was

increased with increasing shade level in *Polyscias balfouriana* "Marginata". In this experiment, SPAD value increased with increasing shade level [4].

Biomass partitioning(%):

There was a significant ($p<0.05$) difference in biomass partitioning between different treatments (Figure 5).Different shade levels significantly ($p<0.05$) influenced the biomass partitioning of *Polyscias guilfoylei* 'variegata' plants.

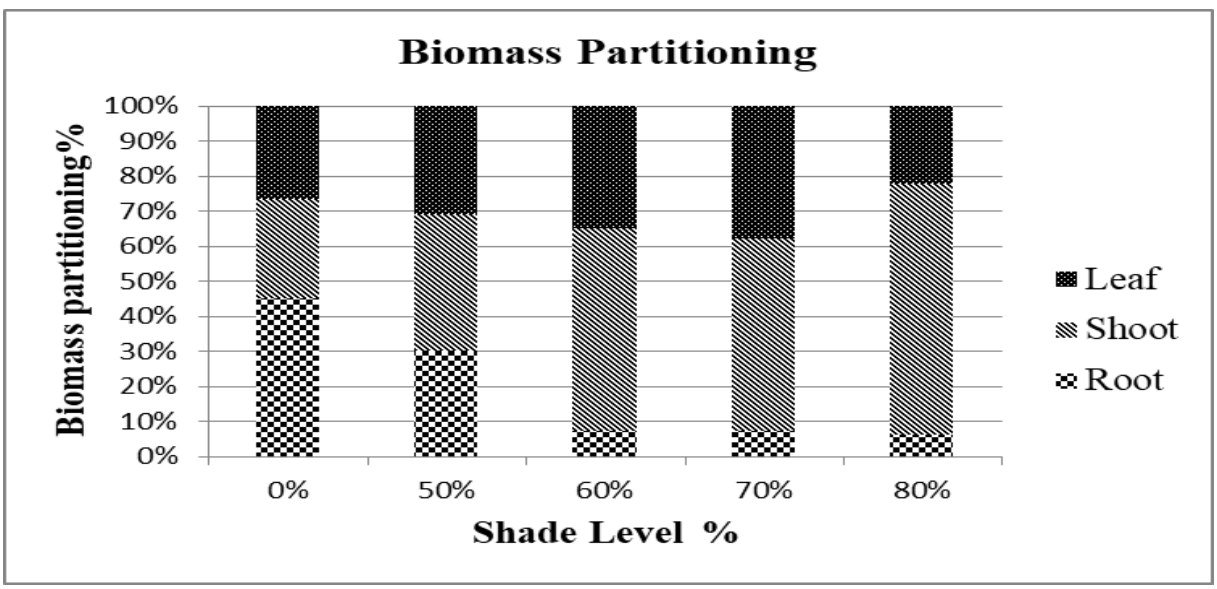

Figure 5: Effect of different shade levels on the biomass portioning of *Polyscias guilfoylei* 'variegata' at 1, 2 and 3 months after transplanting. Bars on graph with the same letter are not significantly different according to the Tukey test at 5% level of probability. (n=3)

Present study was found that biomass partitioning for root, shoot and leaf were significantly ($p<0.05$) higher in 50% of shade level (Figure 5). Allocation of biomass for shoot was highest (71%) in 80% of shade level while lowest (28%) in open field (control). Allocation of biomass for leaves was highest (36%) in 70% of

shade level and lowest in control treatment. Result showed that, biomass partitioning for root, shoot and leaf were higher at 50% of shade level. Optimum partitioning theory (OPT) suggested that, plants shift biomass to capture limiting resources[20]. However, plants grown at this shade level would have received optimum amount of irradiation. There was no limitation of resources for all plants parts as the allocation of resources were higher and almost equal.

In open condition there was a limitation of water in root zone because of higher solar irradiation. Thus the plants try to adept the condition. As such it allocates more biomass to root for received more water than shoot and leaf. This might be the reason for plants under control produced higher root biomass. Allocation of biomass for shoot was highest (71%) in 80% of shade level while lowest (28%) in control. Under high shaded condition light was a limiting factor. It limited the resources of plant to produce vegetative growth. Thus the plants try to compensate this condition. According to the OPT, allocation of biomass for shoot was higher to developed their vegetative growth of plant. This might be the reason for plants under 80% of shade had highest shoot biomass. Allocation of biomass for leaves was highest (36%) in 70% of shade level while lowest in control. Plants under 70% of shade level produced significantly highest leaf area in this experiment and captured more solar radiation. This radiation contributed for photosynthesis and subsequently biomass production. It could be the reason for highest biomass allocation for shoots was obtained plants grown under 70% of shade level. Plant dry matter accumulation affected by leaf area of the plant [17].

Quality:

The Quality of plants was significantly (Mood's Median test, p= 0.00) influenced by different shade levels (Table 1) and it was significantly (p = 0.00) higher in treatment 4 (70% Shade level) compared with other treatments at 3 months after transplanting (MAT).

Table :1 Quality analysis of *Polyscias guilfoylei* 'variegata' at 3 months after transplanting

Shade level (%)	Median
Open field	54.5
50%	70.3
60%	80.5
70%	89.5
80%	67.0
P value	**0.00**

It was found that there were significant differences (Mood's Median test, $p = 0.00$) in the quality of *Polyscias guilfoylei* 'variegata' plants under different shade levels at 3 months after transplanting. Significantly ($p<0.05$) higher scores were obtained in 70% shade level while lowest median value was recorded from open field (T1) plants .

The quality of plants was significantly influenced by different shade levels. Main quality parameters of cut foliage are color of leaves, shoot elongation, leaf expansion and number of leaves in cuttings[21]. In this experiment, plants grown at 70% shade level was scored highest median value while lowest median value was recorded on open field (T1) plants. Level of irradiance is not only influence the photosynthesis process but is also essential for chloroplast development. Therefore plants which were received high irradiance have lower chlorophyll content[22]. This might be the reason for lowest quality of plants grown at open field. Plants grown at 70% of shade level would have received optimum amount of irradiation for better quality as high chlorophyll synthesis enhance the color development[23]. This might be the reason for highest score obtained by the plants grown at 70% shade level.

Conclusion

Polyscias guilfoylei 'variegata' plants grown at 70% shade level showed better performance in growth parameters such as plant height, leaf area and biomass. Further, plants subjected to 70% of shade level received highest score in quality assessment. Lower (80% of shade level) and higher (open field) light levels reduced the growth and quality of *Polyscias guilfoylei* 'variegata' plants. From this study, it could be concluded that 70% shade level is optimum for growing *Polyscias guilfoylei* 'variegata' in the Batticaloa district of Sri Lanka.

References

1. Senevirathne G.A.S.S., Kumari D.L.C. and Disanayake L. (2007). Productivity improvement of foliage plant *Dracaena sanderiana* (Ribbon Dracaena) variety "White". Proceedings of the Sri Lanka Association of Advancement of Science. 63(1), 186.
2. Gaurav, A. K., Raju, D., T Janakiram, B. S., Jain, R., and Krishnan, S. G. (2015). Effect of shade levels on production and quality of Cordyline (*Cordyline terminalis*). Indian Journal of Agricultural Sciences, 85(7), 931-5.
3. Weerakkody, W.A.P. (2004). Horticulture in Sri Lanka, Chronica Horticulture. 44, 23-27.
4. Gunadasa, H. K. S. G., & Dissanayake, P. K. (2012). Optimization of quality in exported Polyscias balfouriana" Marginata" by using different shade levels. Journal of Agricultural Sciences, 7(2)
5. Srikrishnah, S., Peiris, S. E., & Sutharsan, S. (2012). Effect of shade levels on leaf area and biomass production of three varieties of *Dracaena sanderiana* L. in the dry zone of Sri Lanka.
6. Krishnakanth, M., Srikrishnah, S., & Sutharsan, S. (2017). Effects of graded shade levels on the growth and quality of *Cordyline fruiticosa* variety 'Purple Compacta 'in the Batticaloa district. AGRIEAST: Journal of Agricultural Sciences, 11(1).

7. Vilela, A. E., and Ravetta, D. A. (2000). The effect of radiation on seedling growth and physiology in four species of *Prosopis* L.(Mimosaceae). Journal of Arid Environments, 44(4), 415-423.
8. Michal Oren-Shamir., Eugene Gussakovsky., Eliezer Eugene., Ada Nissim-Levi., Kira Ratner., Rinat Ovadia., Yuri Giller., and Yosepha Shahak. (2015). Coloured shade nets can improve the yield and quality of green decorative branches of *Pittosporum variegatum*, The Journal of Horticultural Science and Biotechnology, 76(3), 353-361. DOI: 10.1080/14620316.2001.11511377
9. Conover, C.A. and R.T. Poole. (1986). Nitrogen source effects on growth and tissue content of selected foliage plants. HortScience 21 (4): 1008- 1009.
10. Cockshull, K.E., Graves, C.J., and Carol R. J. Cave. (2015). The influence of shading on yield of glasshouse tomatoes, Journal of Horticultural Science, 67(1), 11-24, DOI: 10.1080/00221589.1992.11516215
11. Mattana R.S., Ming L.C., Marchese J.A. and Marques M.O.M. (2006). Biomass production in plants of *Pothomorphe umbellata* (L.) Miq. Submitted to different shade levels. Brazilian Journal of Medical and Biological Research., 8, 83-85.
12. Kittas, C., Rigakis, N., Katsoulas, N., and Bartzanas, T. (2008). Influence of shading screens on microclimate, growth and productivity of tomato. In: International Symposium on Strategies towards Sustainability of Protected Cultivation in Mild Winter Climate 807, 97-102
13. Prasad S. and Kumar U. (1998). Principles of Horticulture. Agro Botanica
14. Morais, H., Marur, C.J., Caramori, P.H., Ribeiro, A.M.A. de., and Gomes, J.C. (2003). Características fisiológicas e de crescimento de cafeeiro sombreado com guandu e cultivado a pleno sol. Pesquisa Agropecuária Brasileira, v.38, n.10, p.1131-1137. DOI: 10.1590/S0100-204X2003001000001. 10 Set. 2010.

15. Villegas E., Pérez M. and Lao M.T. (2005). Influence of lighting levels by shading cloths on *Cyclamen persicum* quality. Acta Horticulturae, 711, 145-150.
16. Hlatshwayo M.S. and Wahome P.K. (2010). Effects of shading on growth, flowering and cut flower quality in carnation (*Dianthus caryohyllus*). Journal of Agriculture and Social Sciences, 6(2), 34-38.
17. Dalirie M.S., Sharifi R.S. and Farzaneh S. (2010). 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, 38(1), 182-186.
18. Devkota, A. and Jha, P.K. (2010). Effects of different light levels on the growth traits and yield of *Centella asiatica*. Middle East Journal of Scientific Research. 5(4): 226- 310
19. Lykas, C.H. and Katsoulas, N. (2012). Use of shading nets to improve quality characteristics of compact gardenia (*Gardenia jasminoides* Ellis) potted plant. Acta Hort. 952: 281-285
20. Forster, M. A., and Bonser, S. P. (2009). Heteroblastic development and the optimal partitioning of traits among contrasting environments in Acacia implexa. Annals of botany, 103(1), 95-105.
21. Noordegraaf C. (1992). Production and marketing of high quality plants. International Workshop on Floriculture & Nursery Industries and Environment, 353, 134-148.
22. Ballantine J.E.M. and Forde B.J. (1970). The effect of light intensity and temperature on plant growth and chloroplast ultrastructure in soybean. American Journal of Botany, 57(10), 1150-1159.
23. Prasad, S. and Kumar, U. (2003). Stress Physiology of Horticultural Crops. Principles of Horticulture, Agrobios, 191-193.