International Journal of
Agricultural Research

ISSN 1816-4897

Academic
Journals Inc.

www.academicjournals.com

International Journal of Agricultural Research 5 (4): 201-207, 2010
ISSN 1816-4897

Effects of Light Intensity on *Orthosiphon stamineus* Benth. Seedlings Treated with Different Organic Fertilizers

[1]Affendy, H., [1]Aminuddin, M., [2,3]Arifin, A., [1]Mandy, M.,
[1]Julius, K. and [1]Tamer, A.T.
[1]School of International Tropical Forestry,
Universiti Malaysia Sabah, 88999 Kota Kinabalu, Sabah, Malaysia
[2]Faculty of Forestry,
[3]Institute of Tropical Forestry and Forest Products, Universiti Putra Malaysia,
43400 Serdang, Selangor Darul Ehsan, Malaysia

Abstract: The main objective of this study was to investigate the effects of varying light intensities and different organic fertilizers on the growth performance of *O. stamineus* seedlings through measurement of Relative Height Growth Rate (RHGR) and biomass production. Randomized Complete Block Design (RCBD) was used. *Orthosiphon stamineus* was arranged accordingly into three blocks or replicates. The three blocks represented the percentage light intensity. Block 1 (30% of light), Block 2 (50% of light) and Block 3 (100% of light). Each Block had four treatments and 25 plants of *O. stamineus*. The treatments were chicken dung, cow dung, oil palm empty fruit bunch (EFB) and control. The four treatments were arranged randomly in each block. Growth parameters measured were plant height, biomass (aerial portion, root biomass and total biomass within sixth month's period. The 50% Relative Light Intensity (RLI) was better than 30 and 100% RLI. The chicken dung is better than oil palm EFB and cow dung.

Key words: Herb, light, growth, biomass, photosynthesis, fertilizer

INTRODUCTION

Orthosiphon stamineus is believed to have anti-allergic, anti-hypertensive, anti-inflammatory and diuretic properties. *Orthosiphon stamineus* is used as a remedy for arteriosclerosis (capillary and circulatory disorders), kidney stones, diabetes and nephritis (Jaganath and Ng, 2000). According to traditional physiotherapy, *Orthosiphon* tea is used to remove uric acid stones from the kidneys and also used for treating diabetes and hypertension (Lee and Chan, 2004). The leaves have been introduced to Europe and Japan as a health tea that possess diuretic properties and used as a traditional herb for various ailments in Malaysia. *Orthosiphon stamineus* has been trusted traditionally as a diuretic and has been used in treating urinary lithiasis, edema, eruptive fever, influenza, rheumatism, hepatitis, jaundice and biliary lithiasis (Chew *et al*., 2003).

Orthosiphon stamineus shading needs is 30-40% for BRIS soil if planting is done in the dry season (January to June) due to high temperature. Shading can be achieved using shading net or intercrop under other trees. Manures and fertilizers are used in agriculture or forestry practices as nutrient source with the main objective of increasing the supply of plant nutrients already present in the soil (Onuh *et al*., 2008).

Corresponding Author: Affendy Hassan, School of International Tropical Forestry,
Universiti Malaysia Sabah, 88999 Kota Kinabalu, Sabah, Malaysia

According to Taufik *et al.* (2007), the term organic refers to a material relating to or derived from living matter such as from an animal or vegetable origin; not involving or produced with chemical or artificial chemicals.

Plants have an optimal intensity of light. This is the point at which the process of photosynthesis is maximized and plant growth is at its greatest (Neri *et al*., 2003). If the level of light is less, growth is reduced. The point where an increase in light intensity will not increase photosynthesis any more is called light saturation. Light is generally recognized as the most influential environmental factor affecting the growth of trees (Karsai *et al*., 2008). Sufficient understanding on the influence of light on the survival, growth and regeneration of plant is needed for silvicultural guidelines for successful intercropping. A study on light requirement of *O. stamineus* especially for intercropping purposes has not been studied previously. It is a very crucial aspect for determining light intensity as a basic requirement for intercropping possibilities under the canopy of trees or any forest species. Therefore, the main objective of this experiment was to investigate the effects of varying light intensities and different organic fertilizers on the growth performance of *O. stamineus* seedlings through measurement of Relative Height Growth Rate (RHGR) and biomass production.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out since May 2007 to November 2007 at the nursery of School of International Tropical Forestry in Universiti Malaysia Sabah (UMS) located at coordinates 06°02.191 N latitude and 116°07.121 E longitude. According to the Malaysian Meteorological Department, the mean annual rainfall for ten years from 1996 to 2007 for both sites was 2686.02 mm. The mean daily temperature is 23.5 to 33°C.

Materials

A total of 2000 seedlings were established at the nursery through stem cuttings. Each cutting was 6 to 8 inches or 20 cm in length. After one week in the sowing beds, the seedlings were transplanted into perforated polyethylene bags sized 6×9 inches. The planting medium usually used in the preparation of planting material is 3:1 (soil: sand) for regular preparation (Aminah *et al*., 2002).

Experimental Design

In the nursery experiment, Randomized Complete Block Design (RCBD) was used. *Orthosiphon stamineus* was arranged accordingly into three blocks or replicates. The three blocks represented the percentage light intensity. Block 1 (30% of light), Block 2 (50% of light) and Block 3 (100% of light). Each Block had four treatments and 25 plants of *O. stamineus*. The treatments were chicken dung, cow dung, oil palm Empty Fruit Bunch (EFB) and control. The four treatments were arranged randomly in each block. In this study, the ratio that was used in order to compare the growth of *O. stamineus* are 3:2:1.5 and 3:2:0.5 (topsoil: sand: organic manure) respectively as 3:2:1 ratio basis for potting medium in the nursery (Vimala *et al*., 2004). The two ratios used in this study were to investigate the most extreme and the least extreme rate of fertilizer ratio. The experiment was carried out in order to determine the best growth performance of *O. stamineus* under different light intensities and ratios of potting medium in the nursery.

Data Collection

Growth parameters measured were plant height, biomass (aerial portion, root biomass and total biomass) (Vimala *et al*., 2004). The biomass measured using destructive sampling method. The data was collected every week throughout the sixth months of the experiment. The formula for plant height was based on Relative Height Growth Rate (RHGR) as an index of seedling growth (Grotkopp and Rejmanek, 2007);

$$\text{RHGR (cm/cm/week)} = \frac{\ln H_f - \ln H_i}{T_f - T_i}$$

Where:
H_i = Height of seedlings at initial reading.
H_f = Height of seedlings at the end of experiment
T_i = Time at initial reading (Week 0)
T_f = Time at end of experiment (Week n)
ln = Natural logarithm

Statistical Analysis

The data were subjected to statistical analysis using Analysis of covariance (ANCOVA) using Statistical Package Social Science (SPSS) software to find out if there were any significant differences caused by light intensity and fertilizer treatments on *O. stamineus* seedlings in the nursery.

RESULTS AND DISCUSSION

All the parameters showed that there were significant differences for light intensity especially for 50% of light intensity at $p<0.05$ (Table 1). The highest mean RHGR was 0.041 cm/cm/week. For root biomass, it was found that the mean value for 50% and 30% light intensity was 13.33 and 8.77 g for 100% light intensity. For aerial biomass, the mean values were 23.03 g. For total biomass, the highest mean weight was 41.99 g at 50% light intensity.

However, it was found that the mean values for all parameters under 100 and 30% of light intensity were lower compared to 50% light intensity. For example, the RHGR mean

Table 1: Mean results of parameters for different light intensities

Parameters	Light intensity (%)	Mean
RHGR (cm/cm/week)	30	0.039[b]
	50	0.041[a]
	100	0.021[c]
Root biomass (g)	30	13.33[a]
	50	13.33[a]
	100	8.77[b]
Aerial biomass (g)	30	16.76[b]
	50	23.03[a]
	100	11.75[c]
Total biomass (g)	30	31.08[b]
	50	41.99[a]
	100	23.19[c]

Mean values with different letter(s) were significantly different at the 5% level probability ($p<0.05$) using one way ANCOVA and DMRT

Table 2: Mean results of parameters for different fertilizer treatments

Parameters	Treatment	Mean
RHGR (cm/cm/week)	Chicken dung	0.051[a]
	Cow dung	0.034[b]
	Oil palm EFB	0.027[c]
	Control	0.023[c]
Root biomass (g)	Chicken dung	27.85[a]
	Cow dung	10.56[c]
	Oil palm EFB	13.42[b]
	Control	7.81[d]
Aerial biomass (g)	Chicken dung	41.78[a]
	Cow dung	10.09[b]
	Oil palm EFB	10.53[b]
	Control	6.31[c]
Total biomass (g)	Chicken dung	69.64[a]
	Cow dung	20.65[b]
	Oil palm EFB	23.96[b]
	Control	14.10[c]

Mean values with different letter(s) were significantly different at 5% level probability ($p<0.05$) using ANCOVA and DMRT

Table 3: Mean results of parameters for the two planting media in the nursery

Parameters	Ratio	Mean
RHGR (cm/cm/week)	3:2:1.5	0.037
	3:2:0.5	0.031
Root Biomass (g)	3:2:1.5	19.29
	3:2:0.5	10.53
Aerial Biomass (g)	3:2:1.5	20.29
	3:2:0.5	14.07
Total Biomass (g)	3:2:1.5	39.58
	3:2:0.5	24.59

Mean values were significantly different at 5% level ($p<0.05$) using independent sample T-test

value for 100% light intensity was only 0.021 cm/cm/week. This is a similar trend for biomass which showed that 100% light intensity was lower compared to 50% light intensity with 8.77, 11.75 and 23.19 g, respectively.

Table 2 shows the results of the growth parameters studied for the fertilizer treatments. All the mean values were significantly different at 5% level probability ($p<0.05$). Mean value of RHGR for chicken dung was higher with a value of 0.051 cm. For root biomass, chicken dung treatment resulted in the highest mean value at 27.85 g. A similar trend was shown for root biomass aerial biomass and total biomass was highest mean value at 27.85, 41.78 and 69.64 g, respectively.

Table 3 shows the results of the parameters studied for the two planting media used in the nursery for *O. stamineus*. It was found that all mean values were significantly different at 5% level ($p<0.05$). The 3:2:1.5 ratio was higher compared to 3:2:05 ratio for every parameter tested.

In this study, the 50% RLI of growth *O. stamineus* was better than 30% and 100% RLI. The results of this study were supported by Renuka *et al.* (2007) which showed that the maximum survival obtained by *Calamus thwaitesii* and *Calamus metzianus* was under 50% light intensity. He also added that the number of shoots produced was also greater. The 30% RLI (70% shading) showed lower growth for *O. stamineus*. However, *Morinda citrifolia* under *Acacia mangium* (35% RLI) resulted in greater yield of fruits compared to other light intensity regimes (Ota *et al.* 2008). It was also concurred by Jalil *et al.* (2006) that *Labisia pumila* (Kacip Fatimah) under shade house (60-70% shade) produced 160 g per plant

(22.1 t ha^{-1}) fresh weight as compared to only 71 g per plant (9.8 t ha^{-1}) under thinned jungle. A different trend of growth *Polianthes tuberose* L. (Harum Sundal Malam) under 75% shade (35% RLI) was found by Che Radziah *et al.* (2007) and that the rate of net photosynthesis is low, but chlorophyll content, plant height and leaf area were much higher compared to others. This is evidence that light intensity requirements differ with plant species.

Under full sunlight or 100% light intensity, *Calamus hoookerianus* and *Calamus thwaitesii* recorded low survival percentage (Renuka *et al*., 2007). This supported the present study that the growth height and biomass were lower under 100% light intensity rather than under 50% light intensity. Mori (1980) reported that the light requirements for rattan seedlings was about 33 to 50% relative light intensity in order to protect the plants from complete exposure which promotes scorching of leaves and finally death. Abdul Razak and Ismail (2006) found that *Gigantochloa ligulata* stands could be established by intercropping with 60% light intensity conditions and applying a mixture of organic and compound fertilizers.

There are two types of stands in order to determine the light intensity which includes heavy-shade and light-shade types. Kamo *et al.* (2007a) also stated that light-shade type in which the RLI was about 30-40% was much larger than in the tropical rainforests of Malaysia (0.3 to 0.4% RLI), broad leaved temperate forests (mostly less than 5% RLI) and deciduous broad-leaved temperate forests (3 to 5%) or the various types of closed forest. The reason is forest type has a smaller light canopy than light-shade type. In this view, the light-shade type stand expected to facilitate the growth of under planted indigenous seedlings or any cash crops.

However, a different cases with the tree species like dipterocarp species (*Dryobalanops lanceolata, Shorea beccariana* and *Shorea pilosa*) showed that optimum growth at about 20 to 30% light conditions for their initial establishment, above and below which growth rates were lower (Kamo *et al*., 2007b). According to Fenner (1992) light that penetrates through leaf can affect the germination of all species that need light for germination especially seeds that were more exposed to 100% RLI which caused the lower percentage of germination. Fruit yield was much higher at the open site than at the thinned *A. mangium* site. A comparison of the thinned *A. mangium* sites revealed that a relatively high yield was obtained at the 66% thinned treatment on an upper slope due to the relatively high light levels and good drainage (Miyamoto *et al*., 2007).

In terms of biomass production, it was also affected by relative light intensity. It is contradiction with the present study that shading reduced plant root biomass but had no effects on above ground biomass or leaf quality (Jackson and Ash, 2001). In addition, simulated under canopy plants or shading produced more biomass and had higher leaf N concentration than simulated 'outside-canopy' plants. However, Senevirathna *et al.* (2003) studied that shading of rubber reduced leaf expansion rate, plant height and stem diameter and vegetative growth of rubber.

From the experiment it was also supported with the present study that the chicken dung is better than the others due to its high nitrogen content (Zaharah and Vimala, 1987). Oil palm EFB can be used by smallholders as source of fertilizer because its nutrient content is high in Potassium (K) about 40% K_2O based on dry weight of FFB and the rest is Phosphate (P_2O_5) and Magnesium (MgO) (Sumathi *et al*., 2008; Yusoff, 2006). Kasisira and Muyiiya (2009) contradicted with the result present study that cow dung is the best organic fertilizer because cows digest so little of their food. However, in this experiment, cow dung does not perform well. This might be due to the lower content of nutrient and nutrient leaching faster through soil.

CONCLUSION

Amongst the Relative Light Intensity (RLI) regime, 50% RLI was better than 30% and 100% RLI. The 50% RLI is very suitable and can give an optimum yield when planting under shade or intercrops under tree canopies. In addition to that, with an optimum light intensity regime it can produce a high number of leaves as higher biomass production for all portions whether root biomass or aerial portion. Light intensities had considerable effect on height increment of *O. stamineus*. This indicates that the effects of species vary with the change in period and light intensity. These shows that light greatly affect the growth performance of *O. stamineus* in terms of their height and biomass.

For all types of fertilizers used which can be compared with medium ratio, the chicken dung is better than oil palm EFB and cow dung. Different fertilizer ratio could be due to different content of nutrients. The different fertilizer ratio application affected the production of leaf, the number of stems, the green color of leaves and thickness of strip. In this regard, a combination of 50% relative of light intensity and medium soil ratio with chicken dung produces optimum growth performance.

ACKNOWLEDGMENTS

This study was funded by Ministry of Higher Education Malaysia (MOHE) through Fundamental Research Grant Scheme (FRGS)-FRG171-SSK-2008.

REFERENCES

Abdul Razak, O. and P. Ismail, 2006. Effects of intercropping and fertilizers on shoot productivity of *Gigantochloa ligulata*. J. Trop. For. Sci., 18: 147-148.

Aminah, H., Z. Fadzillah and M.Y. Aziah, 2002. Planting Stock Production. In: A Manual for Forest Plantation Establishment in Malaysia, Krishnapillay, B. (Ed.). Forest Research Institute Malaysia, Kuala Lumpur, Malaysia.

Che Radziah, C.M.Z., C.W.N. Salwanie, S.N. Marzuki, H. Haniff, A.R. Zuraida and J. Khairiah, 2007. Relationship of different light intensities towards the physiological processes of Harum Sundal Malam (*Polianthes tuberose* L.) in Malaysia. Malaysian Soc. Plant Physiol., 16: 12-16.

Chew, O.S., N.A. Mohd, I. Zhari, O. Abdul-Rahman, M.N.N. Amin and M.Z. Ezrinda, 2003. Chemometric Classification of Herb–*Orthosiphon stamineus* according to its geographical origin using virtual chemical sensor based upon fast GC. Sensors, 3: 458-471.

Fenner, M., 1992. Ekologi Biji Benih. Dewan Bahasa dan Pustaka, Kuala Lumpur, ISBN-10: 983-62-2197-2.

Grotkopp, E. and M. Rejmanek, 2007. High seedling relative growth rate and specific leaf area are traits of invasive species: Phylogenetically independent contrasts of woody angiosperms. Am. J. Bot., 94: 526-532.

Jackson, J. and A.J. Ash, 2001. The role of trees in enhancing soil nutrient availability for native perennial grasses in open eucalypt woodlands of North-East, Queensland. Aust. J. Agric. Res., 52: 377-386.

Jaganath, I.B. and L.T. Ng, 2000. Herbs: The Green Pharmacy of Malaysia. Vinpress Sdn Bhd, Kuala Lumpur, ISBN-10: 967-81-0281-1.

Jalil, M.N., K. Rezuwan and M.A. Hamid, 2006. Performance of Kacip Fatimah (*Labisia pumila*) production under shade house. Acta Hortic., 710: 399-404.

Kamo, K., L. Jamalung and J. Lapongan, 2007a. Environmental Characteristics of Nurse-Tree Stands Versus Open Sites. Agroforestry Approach to the Rehabilitation of Tropical Lands by Using Nurse Trees. Sabah Forestry Department, Sandakan, ISBN-13: 978-4-9066-35-11-3, pp: 9-12.

Kamo, K., K. Miyamoto, T. Ota, L. Jamalung and J. Lapongan, 2007b. Propagation and Tending of Indigenous Tree Species Suitable for Underplanting. Agroforestry Approach to the Rehabilitation of Tropical Lands by Using Nurse Trees. Sabah Forestry Department, Sandakan, ISBN-13: 978-4-9066-35-11-3, pp: 31-40.

Karsai, I., B. Koszegi, G. Kovacs, P. Szucs, K. Meszaros, Z. Bedo and O. Veisz, 2008. Effects of temperature and light intensity on flowering of barley (*Hordeum vulgare* L.). Acta Biologica Hungaria, 59: 205-215.

Kasisira, L.L. and N.D. Muyiiya, 2009. Assessment of the effect of mixing pig and cow dung on biogas yield. Agric. Eng. Int.: The CIGR E J., 11: 1-7.

Lee, W.L. and L.K. Chan, 2004. Plant regeneration from stem nodal segments of *Orthosiphon stamineus* Benth., a medicinal plant with diuretic activity. *In vitro* Cell. Dev. Biol. Plant, 40: 115-118.

Miyamoto, K., T. Ota and J. Kulip, 2007. Propagation and Tending of Cash Crops Suitable for Underplanting. Agroforestry Approach to the Rehabilitation of Tropical Lands by Using Nurse Trees. Sabah Forestry Department, Sandakan, ISBN-13: 978-4-9066-35-11-3,.

Mori, T., 1980. Growth of *Rotan manau* (*Calamus manan*) seedling under various light conditions. Malaysian For., 43: 187-192.

Neri, D., R. Battistelli and G. Albertini, 2003. Effects of low-light intensity and temperature on photosynthesis and transpiration of *Vigna sinensis* L. J. Fruit Ornamental Plant Res., 11: 17-24.

Onuh, M.O., D.K. Madukwe and G.U. Ohia, 2008. Effects of poultry manure and cow dung on the physical and chemical properties of crude oil polluted soil. Sci. World J., 3: 45-50.

Ota, T., K. Kamo and J. Lapongan, 2008. Initial growth and yield of fruits of mengkudu (*Morinda citrifolia*) in relation to light conditions. JIRCAS Working Rep., 60: 49-52.

Renuka, C., J.P. Thomas and P. Rugmini, 2007. Effects of light on the growth and production of edible shoots of rattan. J. Trop. Forest Sci., 19: 164-167.

Senevirathna, A.M.W.K. C.M. Stirling and V.H.L. Rodrigo, 2003. Growth, photosynthetic performance and shade adaptation of rubber (*Hevea brasiliensis*) grown in natural shade. Tree Physiol., 23: 705-712.

Sumathi, S., S.P. Chai and A.R. Mohamed, 2008. Utilization of oil palm as a source of renewable energy in Malaysia. Renewable Sustainable Energy Rev., 9: 2404-2421.

Taufik, M.M.Y., H.A. Osumanu, W.Y.W. Asrina and A.M.N. Muhamad, 2007. Effect of organic and inorganic fertilizers on Nitrogen and Potassium uptake and yield of sweet corn grown on an acid soil. Am. J. Agric. Biol. Sci., 2: 118-122.

Vimala, P., S. Ahmad, A.M. Arjuna and M.T.M. Senawi, 2004. Effect of organic fertilizers on the growth and yield of Misai Kucing (*Orthosiphon stamineus*) grown under rubber. Proceedings of The National Seminar on Agroforestry 2004, Sept. 21-22. Kuala Lumpur: Forest Research Institute Malaysia.

Yusoff, S., 2006. Renewable energy from palm oil-innovation effective utilization waste. J. Cleaner Prod., 14: 87-93.

Zaharah, A. and P. Vimala, 1987. Keperluan baja bagi tanaman timun di tanah bris (Siri Rudua). Teknologi Sayur-Sayuran, 3: 11-14.