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THE GROWTH OF *PHYLLAGATHIS ROTUNDIFOLIA* UNDER DIFFERENT LIGHT CONDITIONS

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ABSTRACT

P. rotundifolia is a medicinal plant that is used in Peninsular Malaysia. The leaves and roots are used to treat malaria, fever in children and after child-birth to give strength to mothers. This perennial herb is common in the lowland forest. A study was conducted to document the growth requirement of the plant. The physiological growth and leaf development in different light conditions was studied. It was noted that when grown under very low light intensities, the leaf size was larger. The leaf size reduced significantly when planted under partial shades. Besides, light, moist condition is preferred. This paper would prescribe the optimum growth conditions for large scale planting.

Keywords: medicinal plant, physiological growth, light intensities, optimum growth condition

INTRODUCTION

P. rotundifolia is a perennial herb that is often used for post natal care amongst rural folks. They are common in lowland forest. It has been reported that *P. rotundifolia* contained eight cyanogenic glucosides, one alkyl glycoside, two aromatic compounds and seven hydrolyzable tannins (Ling et al. 2002). These compounds are noted in the leaves, roots and stems. Hence, in the pursuit for a healthy and 'green' lifestyle, demand for plant based compounds and supplements are increasing. The objective of this paper is to document the light saturation level for optimum physiological growth of *P. rotundifolia.*

MATERIALS AND METHODS

The growth rates of *P. rotundifolia* were evaluated at Sg Congkak and Sg Tekala Forest Reserves. The growing conditions of these plants are described in Table 1. Light response curves were derived with a portable photosynthesis machine (LICOR 6400, Nebraska, USA). The leaves were subjected to light intensities between 0 to 1500 µmol m^{-2} s^{-1}. These curves were generated at 80% relative humidity (RH), leaf temperature, 28 °C and carbon dioxide concentration, 380 ppm. In addition, chlorophyll fluorescence was also measured at light saturation (I=100%) using fluorescence meter (Hansatech Plant Efficient Analyser, U.K). The excitation light for fluorescence was given at about 500 µmol m^{-2} sec^{-1} for 5 sec.

Measurements of F_o, (initial fluorescence) F_M, (maximum fluorescence) and F_v (variable fluorescence) were obtained from this procedure. F_v is derived as the difference between F_M and F_o. The maximum quantum yield of PSII is represented by F_v/F_m, which highly correlated with the quantum yield of net photosynthesis. (Owens 1994). Leaf area was measured with a portable leaf area meter (CID, Canada) while chlorophyll content was determined using a portable chlorophyll meter (SPAD 502, Minolta Co. Ltd, Japan).

Table 1. Site description and growing condition at each site.

Growing condition	Sg. Congkak F.R.	Sg. Tekala F.R.	Sg. Tekala F.R.
Light intensity	100 $\mu mol\ m^{-2}\ s^{-1}$	60 $\mu mol\ m^{-2}\ s^{-1}$	1000 $\mu mol\ m^{-2}\ s^{-1}$
Relative humidity	90%	90%	60%
Occurrence	Planted on forest floor	Growing naturally (FF)	Planted in the open (PO)

FR= Forest reserved; FF= planted on forest floor; PO= planted in the open

Physiological values are means of three replicates taken from each of the six plots. Comparisons between means were evaluated by *t-test* as indicated at P = 0.01 and 0.05 level using SAS Statistical package. Measurements were done between 9.30 to 11.30 am and on a monthly basis for a period of three months.

RESULTS AND DISCUSSION

The response of photosynthesis (A) to photon flux density (PFD) describes a curve progression, consisting of two phases as demonstrated in Figure 1. An initial linear phase of an increase in photosynthesis with Photon Active Radiation (PAR) through the light compensation point, a progressive decrease in the slope of the curve with increase in PAR to a plateau and decline. Light becomes saturated at above 300 $\mu mol\ m^{-2}\ s^{-1}$ (Figure 1).

The light saturated rate of CO_2 uptake declined when planted in the open when compared with plants growing on forest floor. A_{max} for plants planted in the open was about 70 % of that on forest floor (Figure 1). Though there was a decline in A_{max}, there was no difference in the light saturation of CO_2 uptake. Although the light became saturated at above 300 $\mu mol\ m^{-2}\ s^{-1}$, but the efficiency of light utilization by photosynthesis (ϕ_{co2}) reduced for plants planted in the open. This inferred from the initial slope of the light response curve was between 50of that of the planted on forest floor (Table 2). Comparing between A_{max} and ϕ_{co2} showed that there was a greater reduction in ϕ_{co2} than A_{max}.

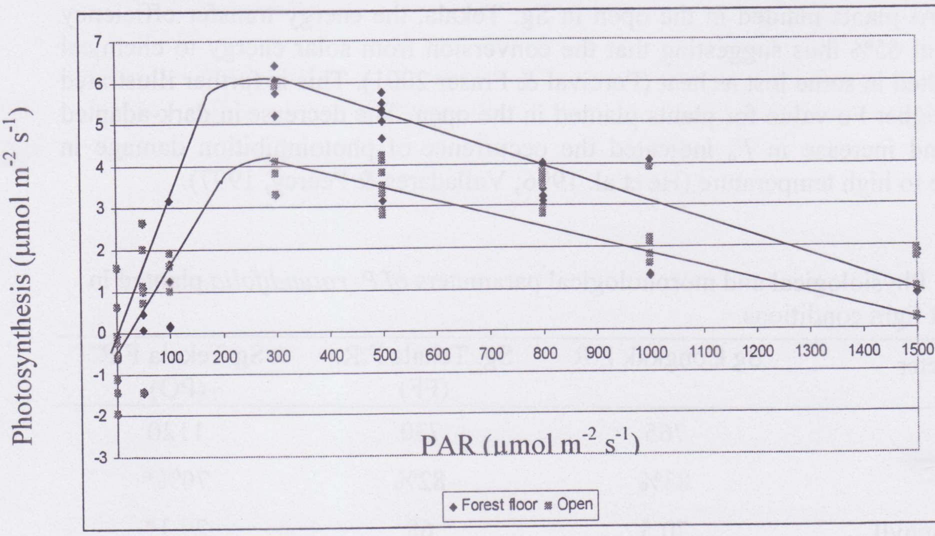

Figure 1. Light response curve for *P. rotundifolia* at 80% RH and 28° C and 380 ppm CO_2.

Photoinhibition can occur when understorey plants are exposed to high light intensities (Gray et al. 1996; Dodd et al. 1998). Above this, the process is impeded and carbohydrates are used for respiration (Larcher 1995). Secondary metabolism like flavonoids, organic acids and phenol derivatives would be affected when carbohydrates productions are reduced in plants (Schlee 1992).

Table 2. Estimated values of CO_2 assimilation at light saturation ($A_{max} \pm$ S.E. µmol m^{-2} s^{1}), and apparent quantum yield for CO_2 ($\phi_{co2} \pm$ S.E.) fixation of light response curve of *P. rotundifolia*. Values are means of 6 replicates. Values in the same column having the same superscript are not significantly different from each other ($p \leq 0.05$).

Species	A_{max}	ϕ_{co2}
Planted in open	6.0 ± 0.7^a	0.04 ± 0.003^a
Planted on forest floor	4.2 ± 0.4^b	0.02 ± 0.002^b

P. rotundifolia grown at RH of about 80 -90% gave the highest Fv/Fm ratio (Table 3). Plants growing natural on forest floor in Sg. Tekala (FF) had a lower ratio because the light was the limiting factor, while at Sg. Congkak (PFF) the physiological parameters were all in their optimum levels. Maxwell and Johnson (2000) reported that most plants had 83% when not subjected to environmental stress. At plants planted in the open in Sg. Tekala, the energy transfer efficiency was about 65% thus suggesting that the conversion from solar energy to chemical has resulted in some lost as heat (Percival & Fraser 2001). This is further illustrated by the higher Fo value for plants planted in the open. The decrease in dark-adapted F_v/F_m and increase in F_o indicated the occurrence of photoinhibition damage in response to high temperature (He et al. 1996; Valladares & Pearcy, 1997).

Table 3. Physiological and morphological parameters *of P. rotundifolia* planted in different light conditions.

Parameter	Sg Congkak F.R	Sg. Tekala F.R. (FF)	Sg Tekala F.R. (PO)
Fm	765	730	1120
Fv/Fm	83%	82%	70%*
Chlorophyll content	70.5	68	29.1*
Leaf area	502.0 cm^2	480 cm^2	185.2 cm^{2*}

FR= Forest reserved; FF= planted on forest floor; PO= planted in the open; *, significant at p=0.01

Significant difference in leaf size and chlorophyll content was noted when plants were planted under different environmental conditions. Leaves were smaller and of lighter green when planted under full light as compared with those under close canopy (Table 3). Heat stress directly reflects structural changes within the membrane and hence alters the chlorophyll content levels (Schreiber & Bilger 1987).

CONCLUSIONS

It is concluded that the light saturation level for both these understory species is about 300 µmol m^{-2} s^{-1}. These plants grow well under high relative humidity of 80% and 90% shade.

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