

Identification of Clonal Differences of Rubber (*Hevea brasiliensis* muell. Arg.) Based on Photosynthetic Parameters

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Introduction

The rubber tree (*Hevea brasiliensis* muell.Arg.) is indigenous to the tropical rain forests in Brazil (Thomas and Panikkar, 2000). It is the only major commercial source of natural rubber (NR). In commercial plantations, the economic life span of rubber tree is about 30 years. In Sri Lanka, the rubber industry provides remarkable benefits to increase the living standards of human being as similar to other rubber growing countries. At the beginning of the commercial plantations, seedlings were used as planting materials (Panikkar *et al.*, 1980). Panikkar *et al.*, (1980) and Seneviratne *et al.*, (1998) showed high variation among individuals in such plantations. However, to avoid high variation in plantations Rubber Research Institute of Sri Lanka has introduced about forty five rubber clones at present, i.e. RRIC 100 series, RRISL 200 series, RRISL 2000 series etc. A long time period is needed to develop, test and release a clone of rubber. Also the growth and yield of the tree vary according to the clone. Photosynthetic and growth parameters are important characters which affect the crop productivity. Carbohydrate is the main product of process of the photosynthesis and subsequently a part of these assimilates are converted into polyisoprene which is the NR of rubber latex. The photosynthetic parameters can also be changed due to type of the clone. Correlations can be exist between selected characteristics of the immature plants with the performance of mature plants of the same clone. If mature tree performance can be forecast from immature trees, it will help to reduce long period spent on the clonal evaluation program. Therefore, the present study was carried out to identification of clonal differences of rubber based on photosynthetic parameters that is very much important to develop early detection criteria for rubber clone.

Methodology

Plants had been pollarded on 2nd February 2012 at the Olikanda bud wood nursery, and were used for this study. All the plants had been planted at density of 500 trees per ha with 3.6 m x 5.4 m spacing. *Hevea brasiliensis* (Muell. Arg.) belonging six genotypes namely RRISL 201, RRISL 2000, RRISL 2001, RRISL 2002, RRISL 2004, RRISL 2005 were selected as treatments in the experiment with three replicates.

Three leaflets were selected from the nursery plants of the each treatment clone to measure leaf chlorophyll content using Chlorophyll Meter at the Copper brown, Apple green and Dark green stages of the leaflets. Carbon dioxide assimilation rates were measured in nursery plants using Portable Photosynthetic System (LI 6400, LICOR Inc., Lincoln, NE, USA) at the different light intensities of 1500, 1000, 500, 300, 200, 150, 100, 70, 50, 30, 0 ($\mu\text{mol m}^{-2} \text{s}^{-1}$). Fully expanded healthy bright green coloured leaflet was selected at the top most whorls from one plant of each clone per day. Gas exchange was measured in one plant

in each treatment clone. The parameters of the light response curve for CO₂ assimilation were derived by fitting data using the non-rectangular hyperbola equation of Thornley and Johnson (1990), and using a non-linear regression (Sigmaplot, version 4, SPSS Inc.).

Results and Discussion

Light response curve of all genotypes showed a common curvilinear shape *i.e.* non rectangular hyperbola (Figure 1). It showed the relationship between the rates of CO₂ assimilation and absorbed photosynthetic active radiation (PAR). The graphs showed that the CO₂ assimilation rates increased with the increasing light intensities up to light saturation point and then became almost constant. RRISL 2005 (Figure 1(f)) showed slightly highest CO₂ assimilation rate than the other clones.

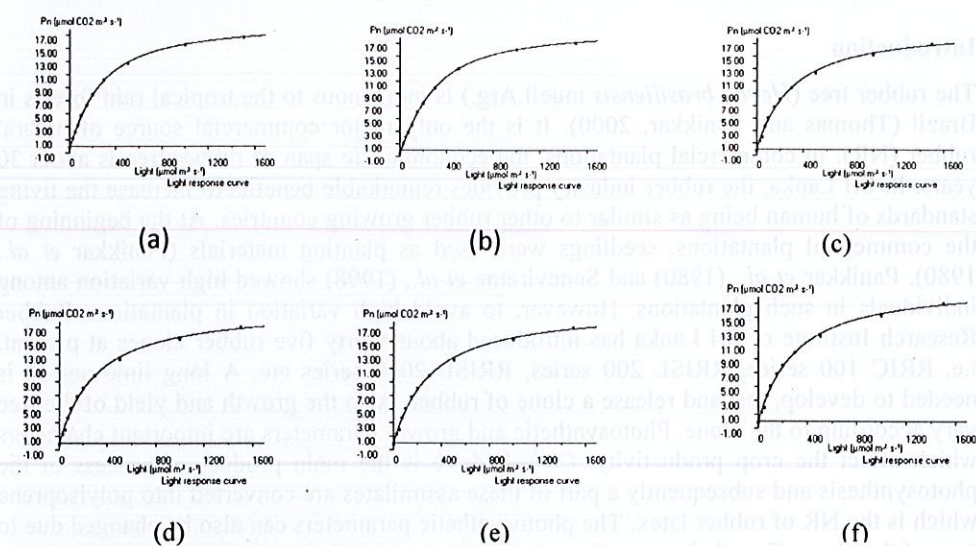


Figure 2: Light response curve for genotypes (a) - RRISL 201, (b) - RRISL 2000, (c) - RRISL 2001, (d) - RRISL 2002, (e) - RRISL 2004, (f) - RRISL 2005

Table 3: Clonal variation in Rd, QE, Amax, LCP and LSP in nursery plants under different light intensities

Clone	Rd ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	QE ($\mu\text{mol CO}_2 \mu\text{mol}^{-1}$ PAR)	Amax ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	LCP ($\mu\text{mol PAR m}^{-2} \text{ s}^{-1}$)	LSP ($\mu\text{mol PAR m}^{-2} \text{ s}^{-1}$)
RRISL 201	-0.346 ^a	0.0587 ^a	19.4 ^a	5.90 ^a	335 ^a
RRISL 2000	-0.509 ^a	0.0524 ^a	20.0 ^a	9.72 ^a	392 ^a
RRISL 2001	0.0147 ^a	0.0599 ^a	20.0 ^a	-0.245 ^a	335 ^a
RRISL 2002	-0.493 ^a	0.0632 ^a	20.1 ^a	7.77 ^a	324 ^a
RRISL 2004	0.00988 ^a	0.0650 ^a	17.8 ^a	-0.152 ^a	274 ^a
RRISL 2005	-0.00866 ^a	0.0568 ^a	21.0 ^a	0.152 ^a	369 ^a

Rd=Dark respiration, QE=Quantum efficiency, Amax= Light saturated rate of photosynthesis, LCP=Light compensation point, LSP=Light saturation point

There is no significant difference ($P < 0.05$) among physiological parameters of different clones of nursery plants (Table 1). Although there were no significant difference in quantum efficiency among clones used, RRISL 2004 showed slightly higher value whilst RRISL 2000 showed the lowest value. The quantum efficiency ranged between 0.05 to 0.06 ($\mu\text{mol CO}_2 \mu\text{mol}^{-1} \text{PAR}$) for all clones, which is in acceptable range for healthy plants. There were no significant differences in light saturated rate of photosynthesis among clones but RRISL 2004 showed tendency in low value. The lowest value in light saturation point showed by RRISL 2004. Therefore, this clone can assimilate CO_2 efficiently under low light conditions. In such a clone quantum efficiency should be high and it was observed as expected in RRISL 2004. Genetic factors and also the environmental factors can effect the clonal differences in physiological parameters.

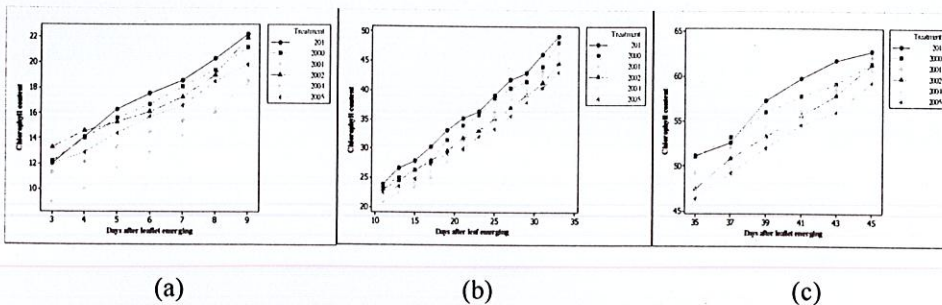


Figure 2: Chlorophyll content at (a) copper brown, (b) apple green, (c) dark green stage

The leaf chlorophyll concentration can vary depending on genotype, nutrient status and leaf age. Chlorophyll content increased with the development stages. The significant differences were not observed among clones at copper brown stage. Chlorophyll content was ranged from SPAD value 9 to 21 at the copper brown stage. The significant differences were not observed among clones at apple green stage through the chlorophyll content increased. Chlorophyll content was ranged from SPAD value 22 to 47 at apple green stage. The significant differences were not observed among clones at dark green stage through the chlorophyll content increased. Chlorophyll content was ranged from SPAD value 48 to 63 at dark green stage (Figure 2). Results showed that all genotypes behaved as the same manner.

Conclusion

Physiological parameters do not show clear significant variance among the clones. There is no significant difference in chlorophyll content of selected clones. Therefore, the use of photosynthetic light response parameters for early detection criteria for rubber clones cannot be recommended without further investigations.

References

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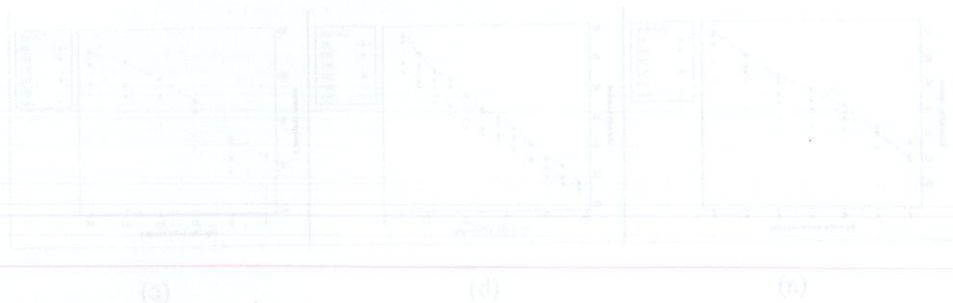


Figure 2: Chlorophyll content in (a) copper brown, (b) apple green, (c) dark green stages

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