

PLASTOCHRON INDEXES IN HEVEA BRASILIENSIS GROWN UNDER TWO WATER REGIMES

BY

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ABSTRACT

Rubber (*Hevea brasiliensis*) plants were grown in two water regimes, so that one treatment (wet plants) received water every other day and other treatment (dry plants) received water every seventh day, during the experimental period. In wet plants, plastochron indexes (PI) advanced more rapidly with time and final leaf size was greater (9.6 cm average). Diminished water supply appears to affect the rate of development and the sequence of developmental events, as observed when plastochron index was plotted against time and when leaf length was plotted against plastochron index of wet and dry treatments. It appears that the plastochron index could be used as a scale for studies connected with the effects of water availability on the development of *Hevea brasiliensis*.

INTRODUCTION

In higher plants, leaves appear periodically and the period between initiation of successive leaves is referred to as plastochron. When successive plastochrons are equal in duration, the plastochron may be used as the unit of a developmental scale.

The plastochron index, a continuous developmental scale based on leaf number, has been used in several physiological studies since its invention (Erickson and Michelin, 1957). Plotting a variable of interest against plastochron index or leaf plastochron index rather than against chronological time can minimise variability so that only a small sample is needed to detect a developmental pattern. To use the plastochron index in such studies however, the effect of the treatment on the plastochron index as well as on the variable must be characterized.

Hevea brasiliensis is an erect plant and leaves arise sequentially on the main stem without branching for nearly one year after planting. Although leaf water potential reach — 20 bars after 6 days without water, almost complete recovery can be observed after rewatering (Samarappuli, 1987).

In this study leaf length was chosen to test the usefulness of the plastochron index in studies of water availability in *Hevea brasiliensis*. The length of a leaf with a given serial no. and the plastochron index were plotted against chronological and developmental time for two water regimes.

MATERIALS AND METHODS

In the first experiment fifteen young (two month old) and uniform seedlings of *Hevea brasiliensis* were chosen. Lengths of the middle leaflets were measured with a transparent plastic ruler, at 12.00 noon. The experiment was conducted in a growth chamber at the University of California, Davis in January 1987.

Air temperature in the growth chamber was 29.4°C relative humidity around 80% where the day time considered was 12 hrs. which is assumed to be comparative to natural tropical condition. The Rubber plants were raised from seeds of clone PB 86 obtained from the Rubber Research Institute of Sri Lanka. The plants were raised in polyethylene pots and the potting medium was a commercial potting mixture commonly used in the USA. Plants were supplied with water upto field capacity of the soil every other day and also, plants were supplied with half strength Hoagland solution at weekly intervals.

In the second experiment six, 12 months old uniform plants were chosen and were watered upto field capacity, just before the experiment was started. Two water regimes were developed by withholding water application for 1 and 6 days. Lengths of the middle leaflets were measured with a transparent ruler every other day during the experimental period, (Nov. 2nd to Nov. 30th 1987) at 9.00 a.m.

The leaf lengths were transformed to PI using Erickson's formular (Erickson and Michelini, 1957).

$$PI = n + \frac{\ln L(n) - \ln(\text{ref. length})}{\ln L(n) - \ln L(n+1)}$$

Where n is the number of leaves on the main stem which are longer than the reference length of 2.7 cm, L (n) is the length of leaf n and L (n+1) is the length of leaf (n + 1). Natural logarithms was used throughout the paper.

RESULTS AND DISCUSSION

The length of the nine leaves (leaf No. 5 to 13) on the main stem were recorded. Table 1 shows the mean leaf length for experiment 1., and Fig. 1 shows the logarithm of leaf length versus days during the experimental period for a typical rubber plant. The plastochron indexes of the chosen plant are in Fig. 2.

Table 1. Mean leaf length of *Hevea brasiliensis* in experiment 1

Date	January									February				
	6	9	12	15	18	21	24	27	30	2	5	8	11	14
Leaf No.	6	9	12	15	18	21	24	27	30	2	5	8	11	14
5	0.5	1.8	3.4	5.0	7.8	8.6	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
6		0.5	1.6	3.0	5.2	6.7	9.5	12.1	12.1	12.1	12.1	12.1	12.1	12.1
7			0.5	1.6	2.9	4.3	6.1	9.0	10.0	10.0	10.0	10.0	10.0	10.0
8				0.5	1.4	2.3	4.1	7.4	10.3	11.0	11.0	11.0	11.0	11.0
9					0.5	1.5	2.0	3.5	5.8	8.6	9.1	9.1	9.1	9.1
10						0.5	1.4	2.3	3.7	5.2	6.1	5.7	7.4	7.4
12							0.5	1.4	2.0	3.3	4.5	7.8	9.1	9.1
13								0.5	1.5	2.2	3.0	4.4	7.4	10.0
									0.5	1.6	2.2	3.1	3.5	3.9

An inspection of the sigmoid growth curves of the leaves suggests that they may be regarded as exponential in their early period. This assumption is confirmed by plotting leaf length logarithmically against time as in Fig. 1, where the relationship between log leaf length and time appears to be linear upto about 5.5. cm leaf length. It is also observed that the lines are approximately parallel and are equally spaced.

The linearity of the relationship between the plastochron index and time can be tested by plotting P. I. as calculated above against days. As shown in fig. 2 a satisfactory straight line occurs for a considerable period.

Table 2. Calculated plastochron indexes for *Hevea brasiliensis* on successive days

Date	Plastochron index
Jan. 12	5.30
15	6.16
18	7.07
21	7.75
24	8.57
27	9.63
30	10.50
Feb. 2	11.50
5	12.33

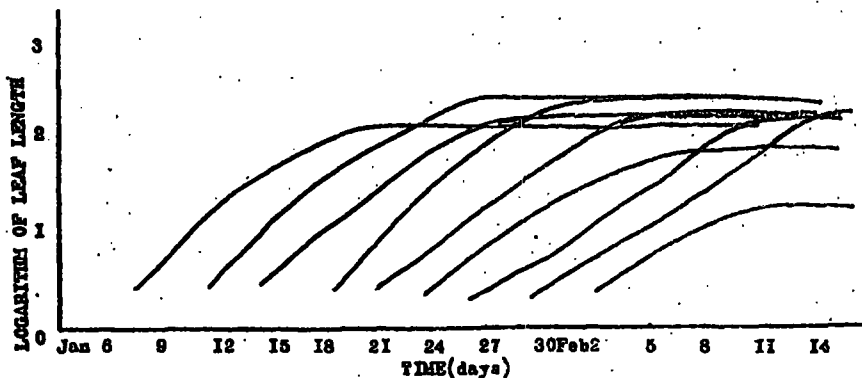


Fig. 1 Logarithm of leaf length of successive leaves in a typical rubber plant against time.

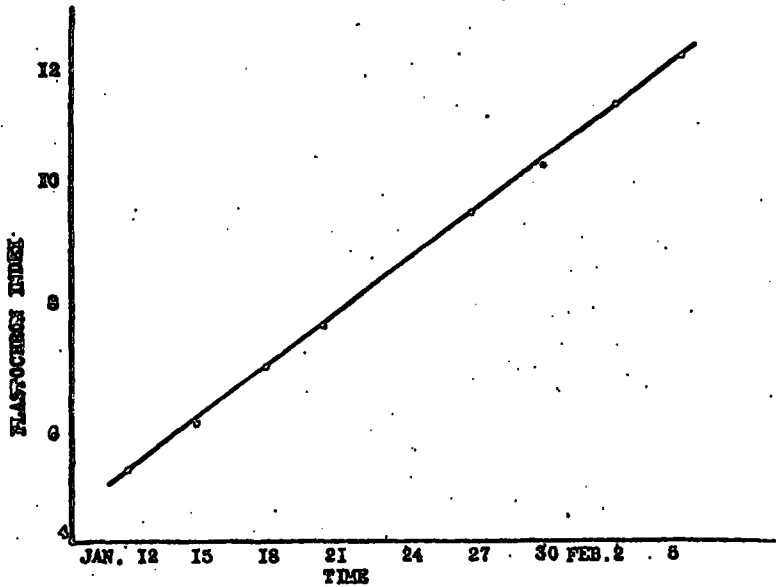


Fig. 2 Plastochron index, calculated from the data of Fig. 1, plotted against time.

The mean length of five leaves from wet plants and four leaves from dry plants were recorded. Table 3, shows the mean leaf lengths for wet and dry treatments and Fig. 3 (a) and 3 (b) show the logarithm of mean leaf length against days for a well irrigated and poorly irrigated plants.

Table 3. Mean Leaf lengths for wet and dry plants of *Hevea brasiliensis*

Wet		November													
Leaf No.		4	6	8	10	12	14	16	18	20	22	24	26	28	30
1		1.2	1.7	2.5	3.2	4.3	5.5	6.7	8.2	10.0	11.0	11.0	11.0	11.0	11.0
2				1.2	1.8	2.7	3.0	3.7	4.5	6.1	8.2	9.5	11.0	12.2	12.2
3					1.2	1.8	2.5	3.5	4.1	4.9	5.5	5.8	6.1	6.2	
4							1.2	2.1	3.0	3.9	5.0	6.2	7.4	8.3	
5										1.2	2.3	4.5	7.4	9.0	10.0
Dry															
1		1.1	1.5	1.8	2.5	3.2	3.7	4.5	5.2	6.1	6.7	7.0	7.0	7.0	7.0
2					1.2	1.7	2.0	2.5	2.9	3.5	4.3	5.0	5.5	5.8	6.1
3									1.3	1.8	2.6	3.3	4.5	5.2	9.4
4											1.4	1.7	2.1	2.6	3.0

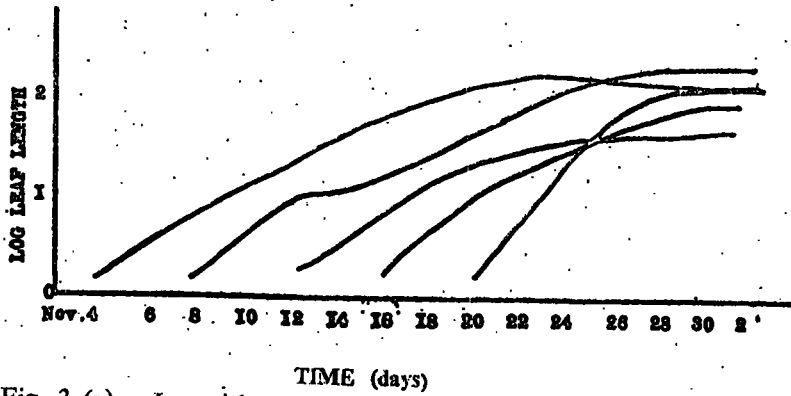


Fig. 3 (a) Logarithm of mean leaf length of successive leaves in wet plants against time.

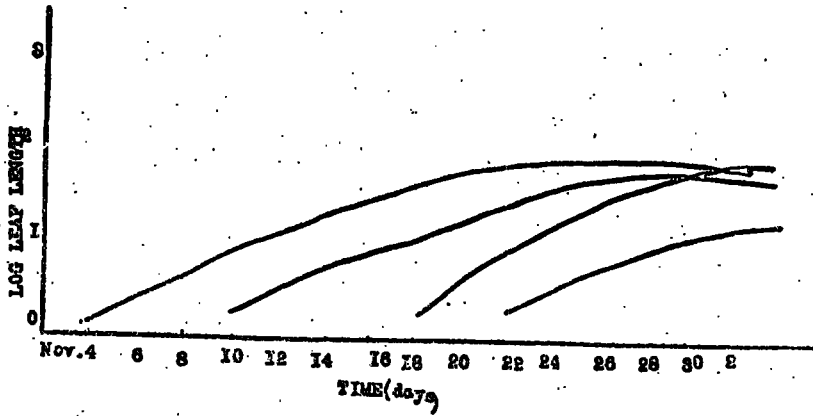


Fig. 3 (b) Logarithm of mean leaf length of successive leaves in dry plant against time.

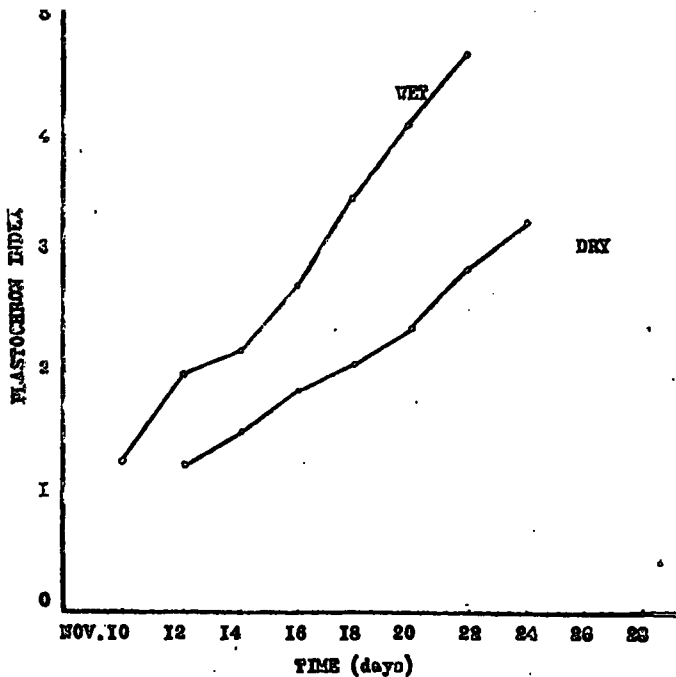


Fig. 4 Plastochron index of wet and dry data against time.

Table 4 Calculated plastochron indexes on successive days in wet and dry plants

Date	Wet P.I.	Dry P.I.
Nov. 10	1.27	—
12	2.00	1.23
14	2.20	1.50
16	2.75	1.83
18	3.50	2.06
20	4.11	2.39
22	4.70	2.90
24	—	3.31
26	—	3.67
28	—	3.93

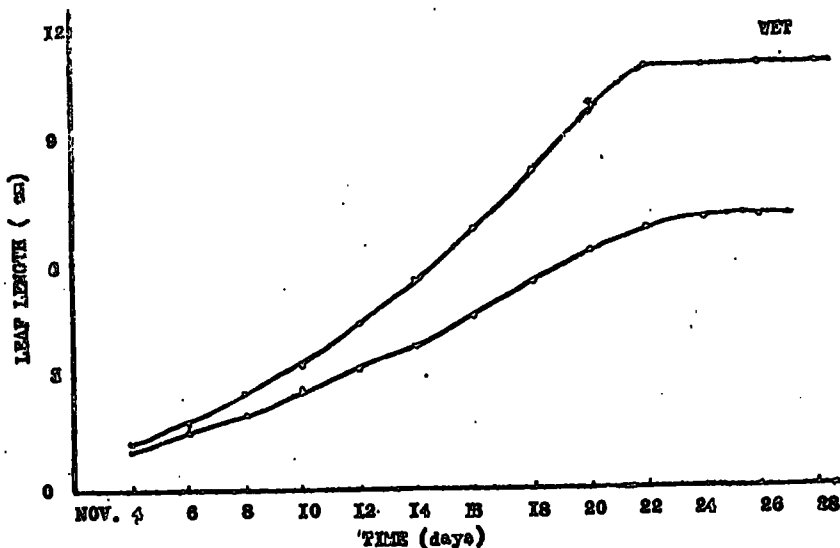


Fig. 5 Length of the leaf No. 1 plotted against chronological time for well watered and poorly watered plants.

Diminution in water supply slowed the rate of leaf production in *Hevea* (Fig. 4). For instance, in Nov. 20th the P.I. for wet and dry plants are 4.11 and 2.39, respectively. Diminished water supply also caused a decrease in final leaf size (Fig. 5). Final length of the leaf No. 1 was 10.95 cm in the well watered treatment and 7.17 cm in the poorly watered treatment.

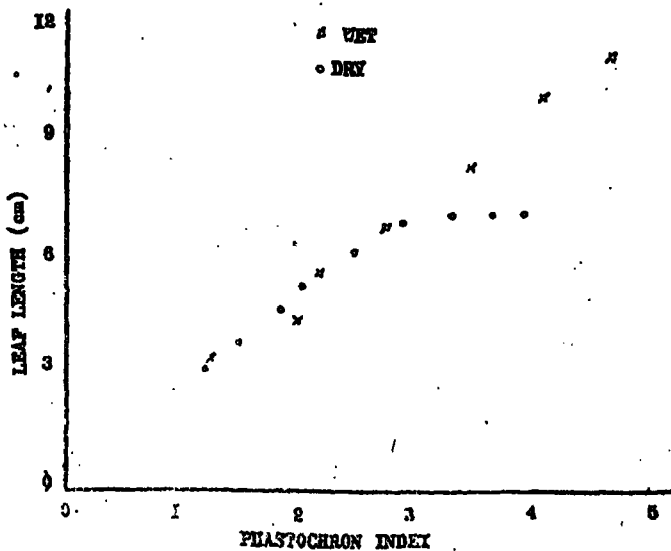


Fig. 6 Length of leaf no. 1 plotted against P.I. for well watered and poorly watered plants.

Leaf lengths were plotted against PI (Fig. 6) and some interesting relationships were observed. Leaf No. 1 developed in a similar manner in the two treatments until about PI 3, but after this stage the well watered leaves continued to grow rapidly for more than two plastochrons while the poorly watered plants grew slowly.

Although the poorly watered plants grew more slowly and had smaller leaves, the general pattern of development was relatively unchanged by water stress. The rate of development was slower with diminished water supply.

The usefulness of the PI has been well documented for developmentally regular plants and the utility of the P.I., is enhanced by the ease and non destructive of the measurement. The P.I. appears to be reliable because developmental events proceed in the same order under different conditions within the physiological range.

The results suggest that the plastochron Indexes of rubber can be used as a scale in studies related to the effects of water supply on *Hevea brasiliensis* development.

This investigation consisted of two experiments using single tree plots replicated 15 and 3 times in experiment 1 and 2 respectively but without a valid statistical design and done in a growth chamber under controlled condition to test the effectiveness of plastochron index in studies on *Hevea brasiliensis* plants. The results seem to suggest the usefulness of this index, but more detailed study will be carried out, to obtain more conclusive results.

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