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Alternative income generation for farmers in the Western Ghats through introduction and promotion of edible shoot producing rattans

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PROJECT PROPOSAL

Project No.	: KFRI 339/2000
Title	: Alternative income generation for farmers in the Western Ghats Through introduction and promotion of edible shoot producing rattans.
Investigator	: Dr. C.Renuka
Objectives	: Introduction of edible rattan species from North East India. Identification of edible rattan species from Western Ghats. Establishment of a rattan shoot stand by planting the seedlings in suitable area. Promoting cultivation for shoot trips among farmers. Study the feasibility for commercialization of rattan shoots among farmers for in cane generation.
Duration	: 2000-2004
Funding Agency	: Western Ghats Development Cell, Planning and Economic Affairs Department, Govt. of Kerala

CONTENTS

Abstract

Two common edible rattan species, one from Lao PDR, *Calamus* species and another from North East India, *Calamus tenuis* were introduced to Kerala and demonstration plots were established at KFRI Field Research Centre at Veluppadam and KFRI Subcentre at Nilambur. The production of new shoots started after an year of outplanting and an average of one shoot per plant could be extracted during the season when production was at the maximum. At Veluppadam the maximum production was noticed during the period from October to January and at Nilambur from July to October.

Studies on the species of *Calamus* occurring in the Western Ghats viz., *C. thwaitesii, C. hookerianus* and *C. rivalis* under different light conditions show that light intensity definitely has an effect on the survival percentage, growth and on the number of shoots produced. Under full sunlight all species registered low survival percentage and low rate of growth. In *C. hookerianus* maximum survival was under 75 per cent light while in *C. thwaitesii* and in *C. rivalis* it was under 50 per cent light. The number of shoots produced was greater under 50 per cent light in all the species. Hence these species can be promoted among farmers as understorey crop in agroforestry systems.

In general, the rattan species studied contain considerable amount of protein, when compared to other palm shoots and leafy vegetables. Among mineral nutrients, calcium, manganese and iron contents are higher which are important elements in human metabolic activities. When compared to well accepted edible species of rattans, the Western Ghats species studied are equally good in their nutrient status. Three-month-old shoots are best suited for consumption. Rattan shoots can be preserved in dry condition or in salt or sugar solutions.

Of the three species, *C. rivalis* and *C. thwaitesii* were found to be economically feasible for introducing as understorey crops in an agro-forestry system. Hence these two species can be promoted among farmers in the Western Ghats for getting an alternative income.

Acknowledgements

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1. INTRODUCTION

Evergreen forests of the Western Ghats form the largest natural home of rattans in South India. Out of the 22 species reported from the Western Ghats, 18 are endemic to this area. The most popular use of rattans is as a raw material to the furniture industry. In addition it finds use in food and medicines also. Many species of rattans supply edible shoots or 'palm hearts'. Each stem has one active growing point (meristem) at the stem tip that produces new leaves and stem. The unlignified tissues produced by this meristem form the edible rattan shoot or palm heart. This vulnerable shoot is protected by the overlapping leaf sheaths. Rattan shoot is a traditional dish in some Asian countries, and is considered as a delicacy in Europe and America. In Asian countries, especially in South East Asia, rattan shoots are available in local markets. In the North Eastern States of India this is used as food as well as medicine. Countries like Laos and Thailand export dried shoots to the USA at a price of US$ 50 per kg. One kilogram will contain about 30 shoots. At local markets 40 – 50 shoots (large cane) will cost about US$ 4-5. For small diameter canes 200 shoots will cost about US$ 8- 10.

Though rattan shoots are used as food in many Asian countries, their intensive cultivation as a means of commerce began only in Laos and Thailand. Usually small diameter rattans are preferred for cultivation because they are easy to cultivate and more number of shoots are produced within a short period.

Rattan shoot farming is a new area in India which has immense potentialities in the rural sector. Promotion of rattan cultivation for shoots among the rural population will provide additional income to them. Plantations for shoot production differ from those planted to produce stems. For shoot production no support or shade trees are required and open fields are universally preferred. Open areas such as unused paddy fields are suitable for raising the crop.

The Western Ghats harbour about 22 species of rattans of which 15 are represented in Kerala (Renuka and Bhat, 2002). A survey among the tribal population revealed that shoots of many rattan species available in the W. Ghats are edible. When wild rattans were available in plenty, people used to collect the shoots for food. Over the past few decades, rattan shoots have undoubtedly become scarce. Such edible species, if domesticated and introduced into large scale cultivation, can provide several substantial benefits. They can be grown in rural areas with significant and direct impact upon local diet as well as income. For domestication and commercial exploitation nutritional information also is crucial.

This project was taken up mainly to introduce some well known edible species of rattans to Kerala and to generate data on the Western Ghats species to support the introduction of rattan species for shoot production and to promote this idea among farmers. The main objectives were:

1. Introduction of edible rattan species from North-East India.
2. Establishment of a rattan shoot stand by planting the seedlings in suitable area.
3. Identification of edible rattan species from the Western Ghats and evaluation of their nutrient contents.
4. Promoting cultivation for shoots among farmers, and to see whether this can be promoted as an understorey crop also.
5. Study the feasibility for commercialization of rattan shoots among farmers for income generation.

2. REVIEW OF LITERATURE

Even though literature on palms is rich in descriptions of their economic and cultural importance (Corner, 1966;; Reis Altschul, 1973; Johnson, 1996), it is very meagre on nutritional analysis. Atchley (1984) compiled all the published information on the nutrient value of palms. Fruits of many palm species have been analysed for their nutritional composition (Menon and Pandalai, 1957; Wu Leung *et al.*, 1961, 1968, 1972; Earle and Jonas, 1962; Watt and Merrill, 1963; CSIR, 1946-1976; Cornett, 1987; Bonde *et al.*, 1990).

Balick and Gershoff (1981) evaluated the nutrient contents of the shoots of *Jessenia batana* and stated that this palm can provide a new source of food protein and oil. The nutrient value and the product profile of the palm heart of *Bactris gasipaes* were published as a result of a CORPEI-CB Project during 2001.

Cultivation of rattans for shoots or palm hearts is a new area in India. Even though plantations are raised for the extraction of shoots in South-East Asian countries, data on the rate of production and nutrient contents are lacking except for the work by Xu *et al.* (1991) and Heamakarn (2000). Both these authors have reported that, compared to other vegetables, rattans are also rich in protein, calcium, vitamins, zinc and iron.

3. MATERIALS AND METHODS

3.1 Introduction of edible species

Two edible species were introduced, *Calamus tenuis* from North Eastern India and *Calamus* species from Lao PDR. Seeds were procured and seedlings were raised in the nursery at KFRI. Demonstration plots were established at Nilambur Subcentre, and Veluppadam Field Research Centre of KFRI. A total of 160 plants were planted for each species in one locality. Observation on the number of shoots produced in each plot was recorded periodically.

3.2 Studies on the W. Ghats species

Three edible rattan species *C. thwaitesii, C. rivalis* and *C. hookerianus* were selected based on the data available from published literature, local knowledge and from the tribals. Seeds were collected; seedlings were raised and outplanted at Nilambur subcentre. To promote cultivation among farmers studies were undertaken to see whether these species can be raised as an understory crop also. To evaluate the performance of the species under different light conditions, an experiment was conducted in split plot design by considering three levels of light (50per cent, 75per cent and 100per cent of light) as the levels of main-plot factor and the three different cane species (*C . rivalis, C. hookerianus* and *C. thwaitesii*) as the levels of the sub-plot factor . The experiment was replicated three times. Within each plot there were 49 plants (7 x 7) with a spacing of 1 m. For a single species 441 seedlings were planted. A total of 1323 seedlings were planted. To cut off excess sunlight appropriate shade nets were used (Charts 1 & 2).

Standardisation of shade requirements

The plastic woven shade nets marketed by the local suppliers showed large variation in the light penetration specifications given. Hence it was found necessary to check the light availability under the nets when they are spread on shade houses. The shade net samples obtained from the market were subjected to measurement of Photosynthetically Active Radiation (PAR) penetration using a Quantum sensor (Li-Cor, Nebraska, USA).The shade given by these nets was thus quantified and graded according to their light interception. From the different types of material available in the market, two different types which provide 25 per cent and 50 per cent shade were selected. The nets were spread on bamboo frames so that the height of the shade net enclosures ranged from 1.8 to 2 m from the ground.

R_1	L_1S_4	L_1S_1	L_1S_2	L_1S_3	L_3S_1	L_3S_2	L_3S_4	L_3S_3	L_2S_1	L_2S_3	L_2S_4	L_2S_2
R_2	L_3S_2	L_3S_3	L_3S_4	L_3S_1	L_2S_3	L_2S_4	L_2S_1	L_2S_2	L_1S_3	L_1S_1	L_1S_4	L_1S_2
R_3	L_2S_1	L_2S_4	L_2S_2	L_2S_3	L_1S_4	L_1S_2	L_1S_3	L_1S_1	L_3S_1	L_3S_3	L_3S_4	L_3S_2

Chart 1. Randomized experimental layout under split plot design

o	O	o	o	O	o	O
o	*	*	*	*	*	O
o	*	*	*	*	*	O
o	*	*	*	*	*	O
o	*	*	*	*	*	O
o	*	*	*	*	*	O
o	O	o	o	O	o	O

O - Border plant
* - Inner plant

Chart 2. Sketch of a single subplot

Observations were recorded on survival, height, number of suckers produced and number of suckers extracted periodically. For the purpose of statistical analyses, data from only the net plot containing 25 plants (5 x 5) from each gross plot of 49 plants (7 x 7) were considered (Chart 2). The data on survival percentages were transformed to angular values cumulative height were transformed to logarithmic values and cumulative number of suckers was transformed to square root scale before they were subjected to analysis of variance. Regression equations were fitted for survival percentages, cumulative height and cumulative number of suckers for different species and shade levels over periods wherever necessary.

Survival

Regression model of the following form was fitted to the data on survival

$$y_t = y_0 e^{-rt} \varepsilon_t \qquad (1)$$

where y_t = number plants surviving at time 't'

y_0 = initial number of plants (25)

e = base of natural logarithm

r = survival rate

t = time (months)

ε_t=Error term

Cumulative height

The model fitted was

$$\ln y_t = a + b\,t + \varepsilon_t \qquad (2)$$

where y_t = cumulative total height (cm) at time t
a, b are parameters
ln = natural logarithms
t = time (months)

Cumulative number of suckers

The model fitted was

$$\sqrt{y}_t = a + b\,t + \varepsilon_t \qquad (3)$$

where y_t = cumulative number of suckers at time t
a, b, and t are as given above

3.3 Nutrient analysis

Shoots were extracted when they reached a height of 1.5 m. The top one metre of the stem was cut and some of the outer leaf sheaths were removed. These samples were transported to the laboratory, where the remaining leaf sheaths were removed, the shoots were split and dried at 70 °C in an oven till a constant weight was obtained on repeated weighing. The dried samples were powdered and kept in dry sealed bottles until nutrient analysis could be carried out.

Moisture

Moisture estimation was carried out using standard method (AOAC, 1990).

Crude protein

Crude protein was determined using micro- Kjedahal method. Total nitrogen was estimated and multiplied it with 6.25 to find out crude protein content (Sadasivam and Manikam, 1992).

Crude fibre

Crude fibre was determined by acid –alkali digestion method (AOAC, 1970)

Phosphorus

Phosphorus was determined using Spectrophotometer, after digesting a known weight of sample with H_2SO_4.

Potassium

Potassium was determined using flame photometer, by digesting a known weight of the sample with H_2SO_4.

Micro nutrients (Zn, Cu, Fe, Mn, Pb, Ca, Mg)

The micronutrients were determined through the atomic absorption spectrophotometer method. The plant samples digested with H_2SO_4 were passed through AAS using different lamps and calibrated for different micronutrients.

Preservation techniques

Preservation of shoots was tried by drying and with addition of salt and sugar solutions.

3.4 Cost -benefit ratio estimation

In order to assess the economic feasibility of the Net Present Value (NPV), Benefit-Cost Ratio (BCR) at three discount rates of 6 per cent, 9 per cent and 12 per cent along with the Internal Rate of Return (IRR) were estimated.

4. RESULTS

4.1 Introduction of edible species

Two edible species were introduced, *Calamus tenuis* Roxb. from North-eastern India and *Calamus* sp. from Lao PDR. *C. tenuis* is a widespread rattan and this is a preferred edible species. *Calamus* sp. from Lao PDR is also very much preferred in Laos for edible purpose and it has recently come under extensive cultivation. The major portion of the shoots coming to the Vientiane market is from the plantations.

Demonstration plots were established for the introduced species at Veluppadam and Nilambur with 160 plants for each species in one locality.

4.1.1 *Number of new shoots produced*

The seedlings were outplanted after the first monsoon showers. Production of new shoots started after 20 months. At Veluppadam, *Calamus* species started production of new shoots at the end of 5 months after outplanting. The data shows that there was a seasonal variation in the production of new shoots. At Veluppadam, both species showed similar trends in the production of shoots (Tables 1, 2). During summer season, April to June, the production was less. Gradually the production increased during the rainy season, and high production was noticed during the period from October to December reaching a maximum in January. *C. tenuis* produced 202 shoots while *Calamus* species produced 155 shoots during the maximum production period. During summer season, the production was 109 and 93 respectively.

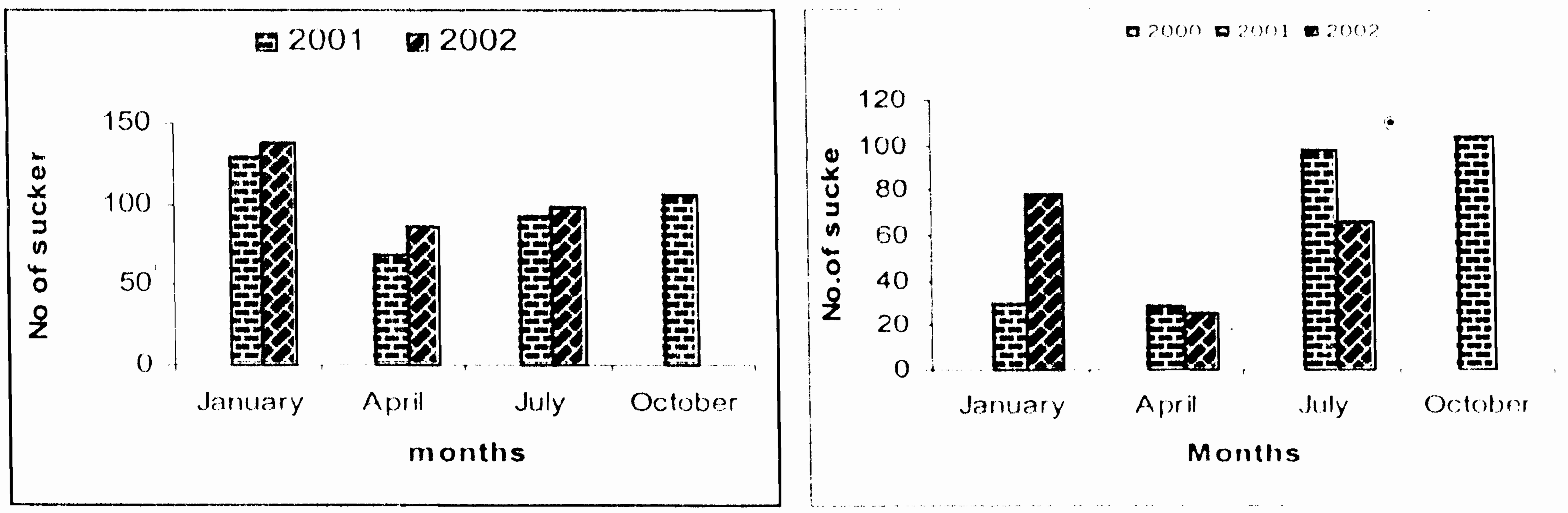
At Nilambur the maximum production was noticed during the third quarter viz., from July to November so that the maximum number was obtained in October (Tables 1, 2). *C. tenuis* produced 154 shoots during this season while *Calamus* species produced 241.

Table 1. Yearly production and extraction of shoots – *C. tenuis*

Location	Month	2000 No.of shoots produced	2000 No. of shoots extracted	2001 No.of shoots produced	2001 No. of shoots extracted	2002 No. of shoots produced	2002 No. of shoots extracted
Veluppadam	January			202	129	207	138
	April			109	68	129	86
	July	0	0	143	92	147	98
	October	0	0	154	105	0	
Nilambur	January			51	30	117	78
	April			44	28	41	25
	July	0	0	152	98	99	66
	October	0	0	154	104	0	

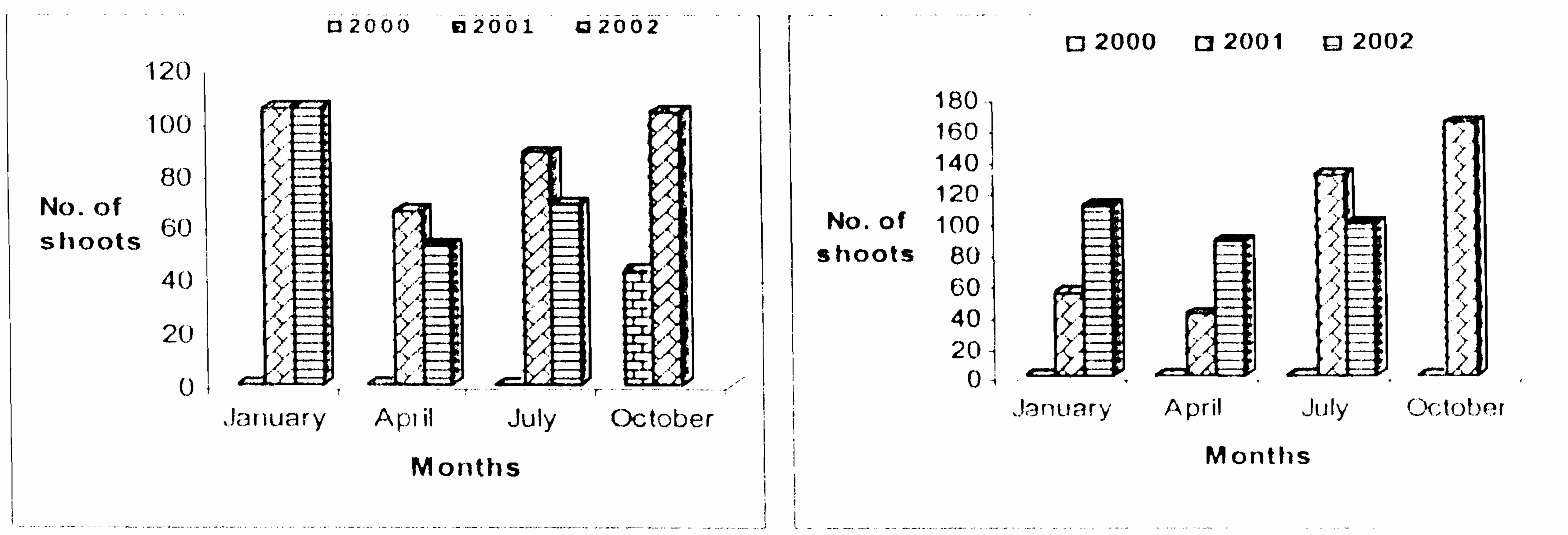
Table 2. Yearly production and extraction of shoots – *Calamus sp.* (Lao PDR)

Location	Month	2000 No.of shoots produced	2000 No. of shoots extracted	2001 No.of shoots produced	2001 No. of shoots extracted	2002 No. of shoots produced	2002 No. of shoots Extracted
Veluppadam	January			155	105	165	105
	April			93	66	84	53
	July	0	0	124	88	103	68
	October	66	43	142	103		
Nilambur	January			82	54	166	109
	April			61	40	135	87
	July	0	0	186	129	152	98
	October	0	0	241	163		



Veluppadam Nilambur

Fig.2. *C. tenuis*. Seasonal variation in the production of shoots.



Veluppadam Nilambur

Fig. 3. *Calamus* sp. Seasonal variation in the production of shoots

4.1.2 Number of shoots extracted

At Veluppadam, in *C. tenuis,* 129 shoots could be extracted in January during the first year whereas only 30 shoots could be extracted at Nilambur. During this period, in *Calamus sp.*, 105 shoots were extracted at Veluppadam while 54 shoots were extracted at Nilambur. In *C. tenuis* about 105 shoots could be extracted from both localities during October. In *Calamus* sp. 163 shoots could be extracted at Nilambur during October while 103 shoots were obtained from Veluppadam.

4.2 Introduction of Western Ghats species

Three species were selected from the W. Ghats, *Calamus thwaitesii* , *C. hookerianus* and *C. rivalis*. They were planted under different light conditions (Charts.1&2). Survival, growth in height and production of new shoots were monitored periodically.

4.2.1 *Survival*

Result of the analysis of variance on survival percentage are shown in Table 3. The effects due to light, species, period and the interaction between species and period and between species and light turned out to be significant which indicate that the effect of species varies with the change in periods and also with the change in light intensity. The non-significant interaction between light and period indicates that the effect of light does not vary over period .

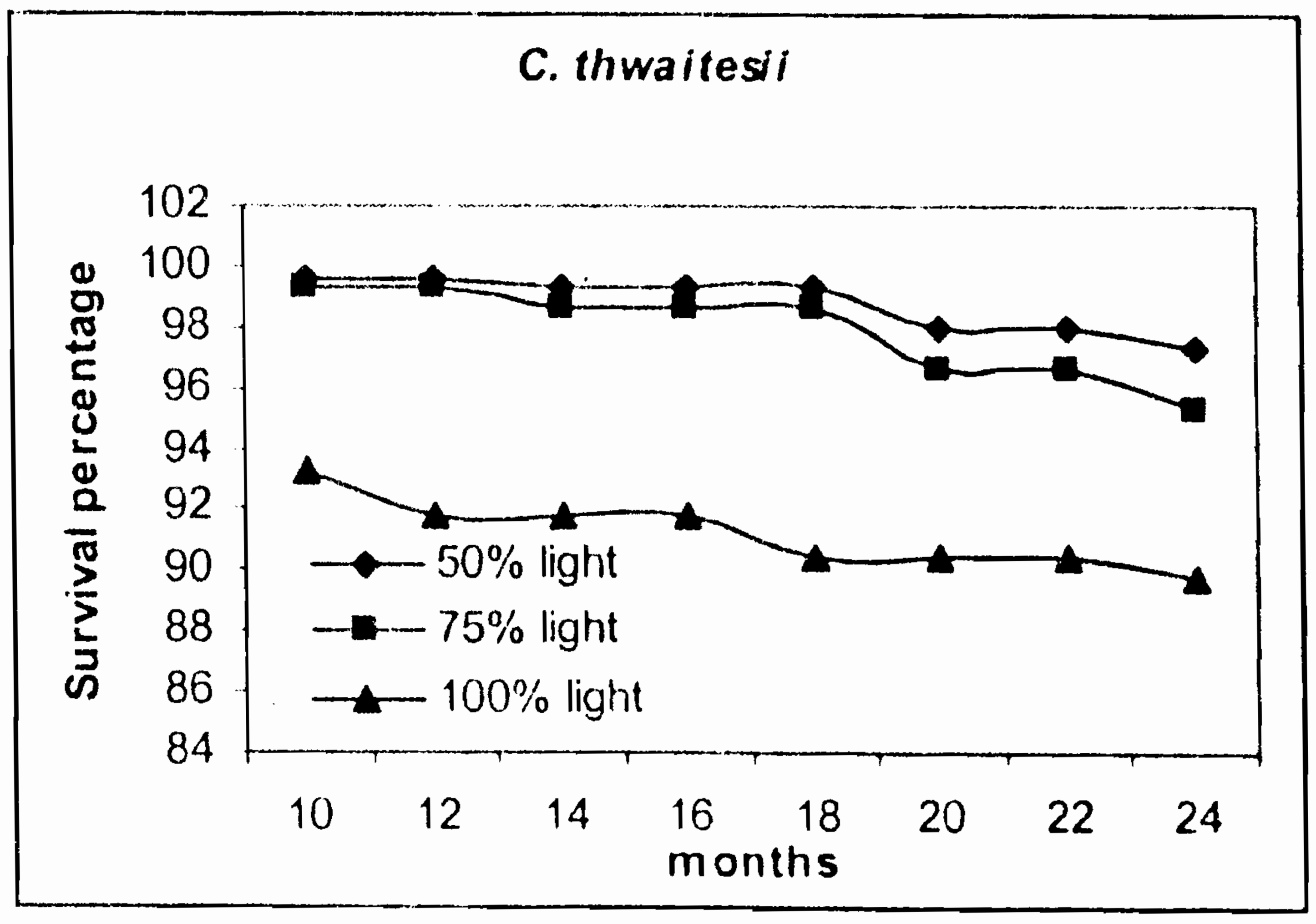
Table 3. Analysis of variance of data on survival (percentages) in angular values

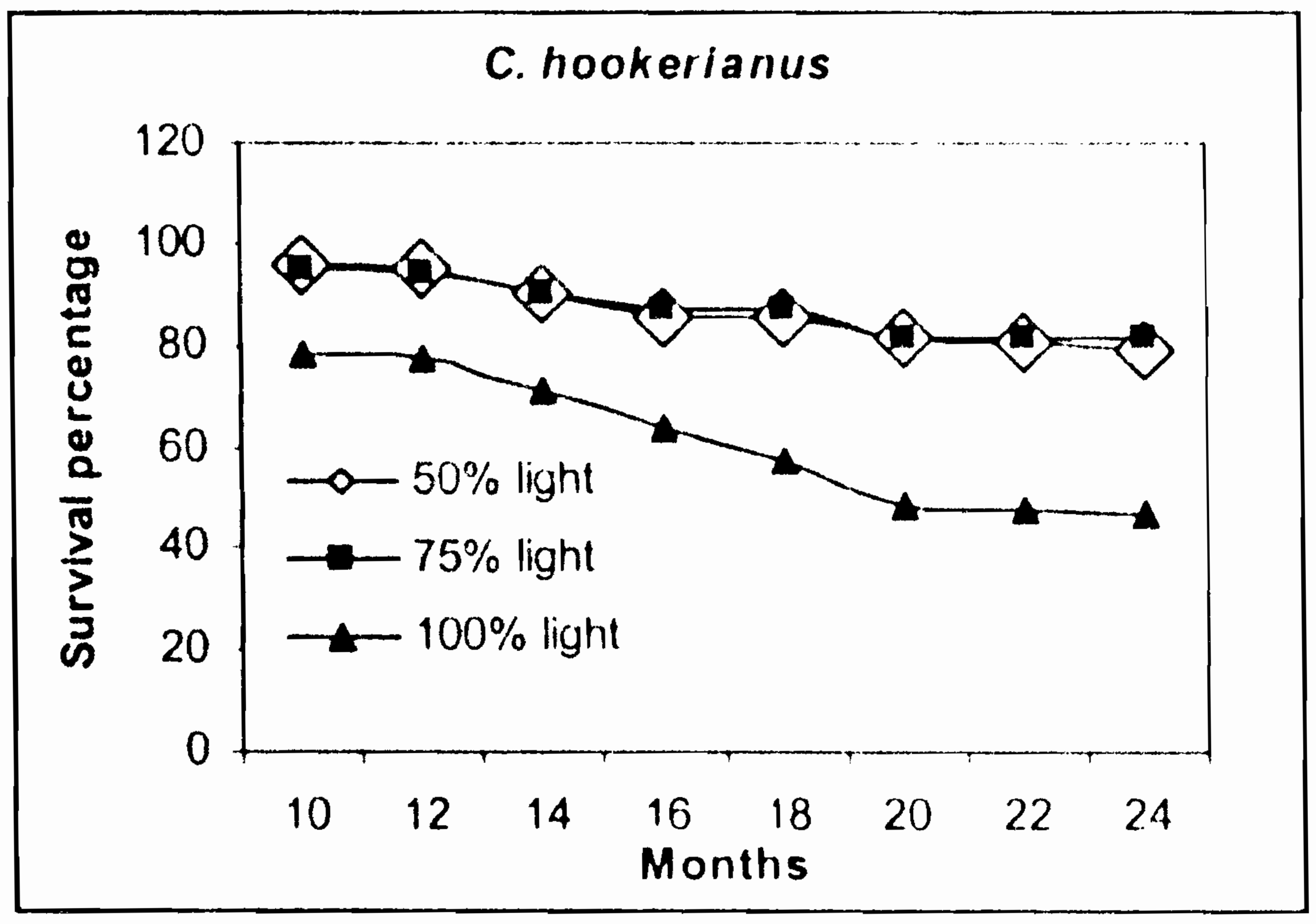
Sources	Degrees of freedom	Mean sum of squares	F value
Light	2	2429.95	25.11**
Replication	2	46.19	0.48
Error(1)	4	96.77	
Species	2	6271.45	72.55**
Species x light	4	424.54	4.91**
Error(2)	12	86.44	
Period	7	299.06	38.70**
Species x period	14	71.24	9.22**
Light x period	14	5.48	0.71
Light x species x period	28	3.88	0.50
Residual	126	7.73	

** - significant at P= 0.01

Table 4. Mean survival percentage of seedlings under different light intensities

Species	Light (%)	Period (Months)							
		10	12	14	16	18	20	22	24
C. hookerianus	50	95.92	95.24	89.80	85.76	85.03	80.95	80.27	78.91
	75	95.24	94.56	90.48	87.08	87.08	81.63	80.95	80.95
	100	78.23	77.55	70.75	63.95	57.15	48.30	47.62	46.94
C. rivalis	50	100.00	100.00	99.63	98.64	97.96	97.96	97.28	96.60
	75	99.32	99.32	97.96	97.95	97.95	97.28	97.28	95.24
	100	99.32	97.95	96.24	95.92	94.85	93.89	93.88	93.20
C. thwaitesii	50	99.56	99.56	99.32	99.32	99.32	97.96	97.96	97.28
	75	99.32	99.32	98.64	98.64	98.64	96.60	96.60	95.24
	100	93.23	91.84	91.84	91.82	90.48	90.48	90.48	89.80





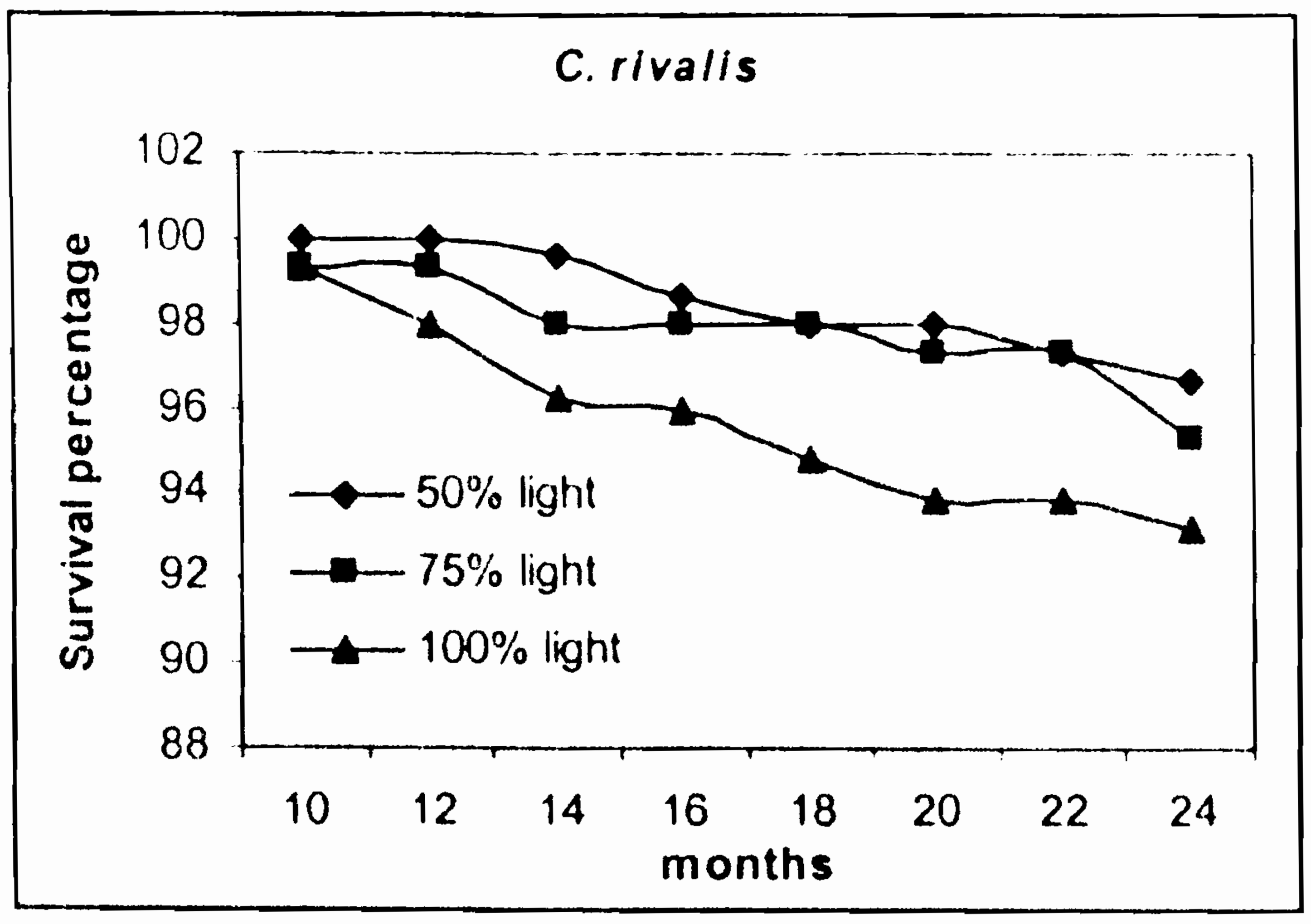


Fig. 4. Mean survival percentage of the three species under three different light intensities

From the experiment it is clear that light intensity affects the survival percentage. In *C. hookerianus* maximum survival percentage is seen under 75 per cent light followed by 50 per cent light. Under full sunlight, *C. hookerianus* and *C. thwaitesii* registered low survival percentage. *C. hookerianus* was the most affected, the mean survival percentage being only 47 at the end of two years (Table 4). *C. rivalis* performed well under all the three light conditions. Here the maximum survival occurred under 50 per cent light followed by 75 per cent light. Under 100 per cent light too this species registered 93.2 per cent survival. In *C. thwaitesii* also maximum survival was shown under 50 per cent light (Fig. 4).

In order to examine the trend in survival percentage of different species over period, regression analysis was done for survival (Table 5). The adjusted R^2 was around 0.87 or more for all the three species indicating satisfactory fit of the models selected.

Table 5. Fitted equations for survival for different species

Species	Regression Equation	Adjusted R^2
C. thwaitesii	$Y=25^{e0.00213\,t}$	0.871
C. hookerianus	$Y=25e^{0.0150\,t}$	0.985
C. rivalis	$Y=25e^{0.00188\,t}$	0.910

4.2.2 *Height*

The results of variance (ANOVA) on cumulative total height are shown in Table 6. The effects due to light, interactions between species and period and between light and period turned out to be significant. The significant interaction between the species and period indicates that the species differed in their height growth pattern across time. Also the significant interaction between light and period indicates that the effect due to light varies over the period.

Table 6. Analysis of variance of data on cumulative total height (cm) in logarithmic scale.

Sources	Degrees of freedom	Mean sum of squares	F ratio
Light	2	7.03	58.51**
Replication	2	0.35	2.93
Error(1)	4	0.12	
Species	2	33.29	118.41**
Species x Light	4	2.57	9.14**
Error(2)	12	0.28	
Period	7	7.76	169.11**
Species x period	14	0.60	13.18**
Light x period	14	0.54	11.67**
Light x species x period	28	0.14	2.97**
Residual	126	0.05	

** - significant at P= 0.01 ; * - significant at P= 0.05

Table 7. Mean cumulative height of three species under three different light intensities

Period (months)	Cumulative height (cm)								
	C. thwaitesii			*C. hookerianus*			*C. rivalis*		
	50% L	75% L	100%L	50% L	75%	100%L	50% L	75% L	100% L
6	170.00	216.00	369.67	175.67	133.67	134.33	402.33	307.00	372.33
10	216.33	253.00	378.00	201.67	143.33	140.00	550.00	378.00	446.67
15	697.00	656.33	398.00	656.00	485.33	293.67	843.00	877.67	1082.67
17	732.33	685.67	296.67	643.33	491.33	171.33	989.33	985.67	1178.67
19	840.67	723.67	321.67	703.33	500.00	148.33	1332.00	1316.67	1450.33
21	921.33	998.00	328.67	730.33	537.67	132.00	2233.33	2111.33	2033.00
23	923.33	1192.33	331.67	717.33	533.67	134.33	2602.00	2585.67	2352.33
25	945.33	1310.33	365.00	737.33	559.33	137.67	2909.33	3046.33	2726.33

In *C. thwaitesii* and *C. rivalis* maximum height was attained under 75 per cent light whereas in *C. hookerianus* maximum height was shown under 50 per cent light. In all the cases growth was minimum under full sunlight (Table 7, Fig. 5).

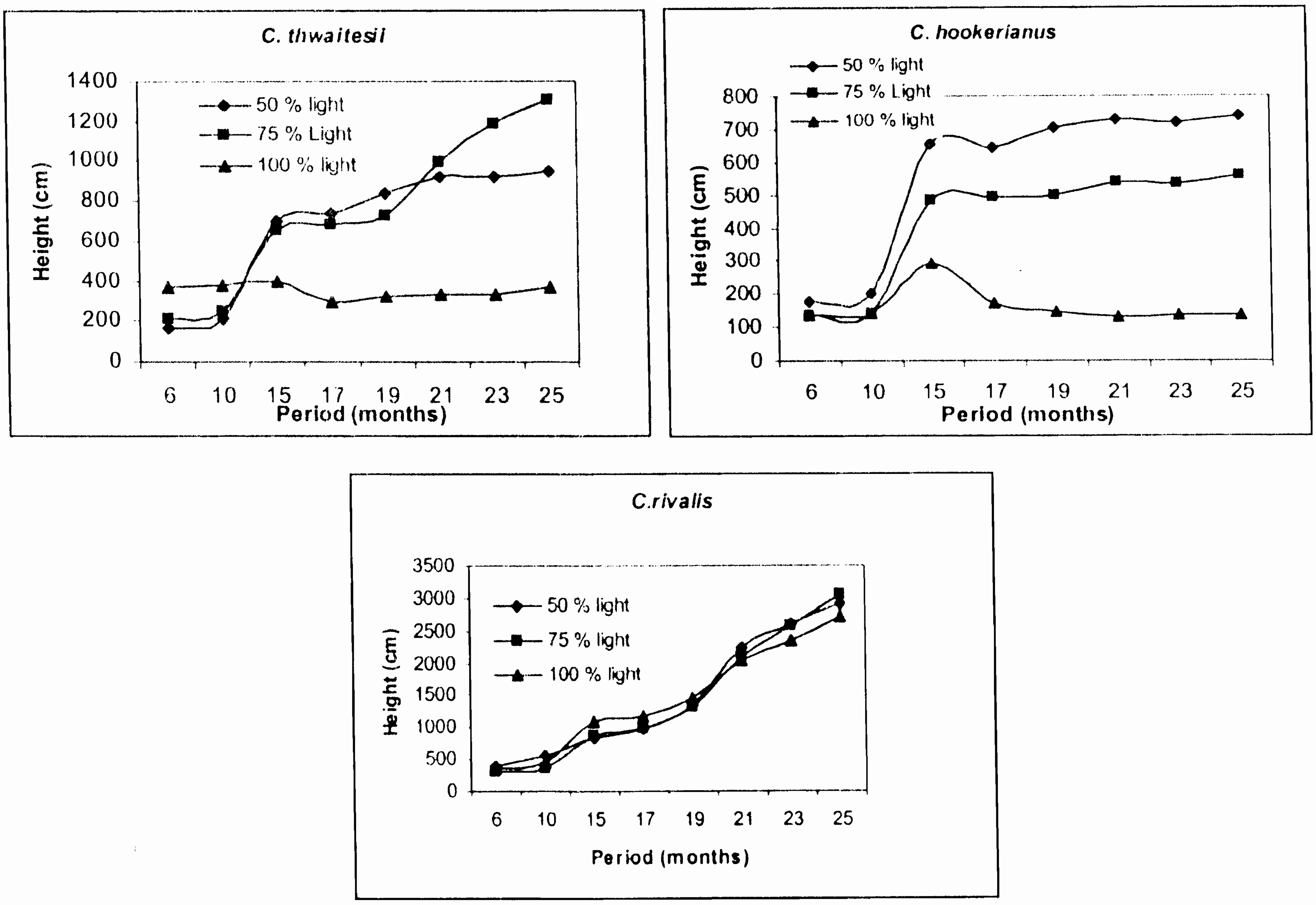


Fig. 5. Mean Cumulative height of the three species under three different light intensities

Since interactions between the species and period and between light and period were found significant, the regression analysis was done separately with respect to cumulative height corresponding to different species and different light intensities (Tables 8, 9). The adjusted R^2 values was found high indicating that the chosen model was reasonable.

Table 8. Fitted equations for cumulative height for different species

Species	Regression Equation	Adjusted R^2
C. thwaitesii	$\ln y = 5.106+0.0704t$	0.932
C .hookerianus	$\ln y = 4.701+0.0683t$	0.719
C. rivalis	$\ln y = 5.067+0.117t$	0.981

Table 9. Fitted equations for cumulative height for different light intensities

Light intensity (%)	Regression Equation	Adjusted R^2
50	$\ln y = 4.898+0.103t$	0.972
75	$\ln y = 4.628+0.114t$	0.971
100	$\ln y = 5.173+0.0718t$	0.960

4.2.3 *Shoot production*

Results of the variance (ANOVA) on cumulative number of new shoots produced are given in Table 10. The effects due to species, light, period, interactions between species and period and between light and period turned out to be highly significant. The significant interaction between the species and period and also between light and period indicates that there was significant effect due to species and light across time with respect to cumulative number of shoots.

Table 10. Analysis of variance of data on cumulative number of shoots in square root scale.

Sources	Degrees of freedom	Mean sum of squares	F ratio
Light	2	32.41	40.67**
Replication	2	5.5	6.9
Error(1)	4	0.80	
Species	2	163.06	43.04**
Species x light	4	7.13	1.88
Error(2)	12	3.79	
Period	7	92.93	255.9**
Species x period	14	9.65	26.65**
Light x period	14	2.39	6.61**
Light x species x period	28	0.53	1.47
Residual	126	0.36	

** - significant at P= 0.01

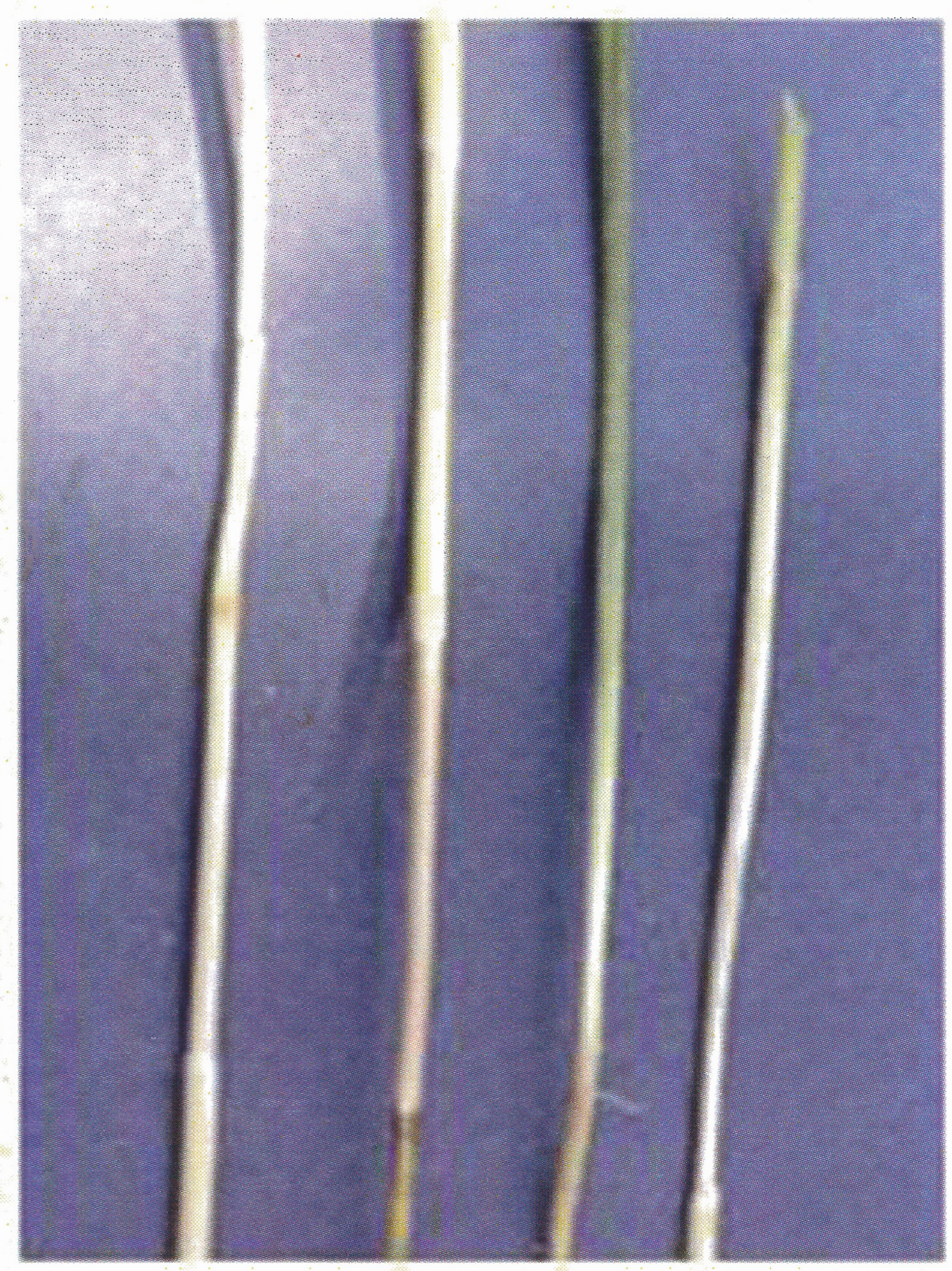
Table11. Total number of shoots present under three light intensities

Species	Light %	Period (Months)					
		15	17	19	21	23	25
C hookerianus	50	36	54	66	75	74	82
	75	20	49	54	52	52	51
	100	4	4	5	5	4	4
C. rivalis	50	97	116	116	134	140	140
	75	131	131	132	131	130	134
	100	79	109	114	117	128	129
C. thwaitesii	50	13	25	56	56	57	75
	75	16	50	64	60	61	60
	100	2	11	10	37	38	43

Number of shoots produced was greater under 50 per cent light in all the species. Minimum number was produced under 100 per cent light. *C. hookerianus* was most affected under full sunlight. More shoots were produced by *C. rivalis* under all the three light intensities (Table 11, Fig.6,Pls. 1-2).

Extraction of shoots

Extracted shoots



Removal of sheaths

Plate – 1

Experimental plot - a view

Extractable *C. rivalis*

Extractable *C. hookerianus*

Extractable *C. thwaitesii*

Plate – 2

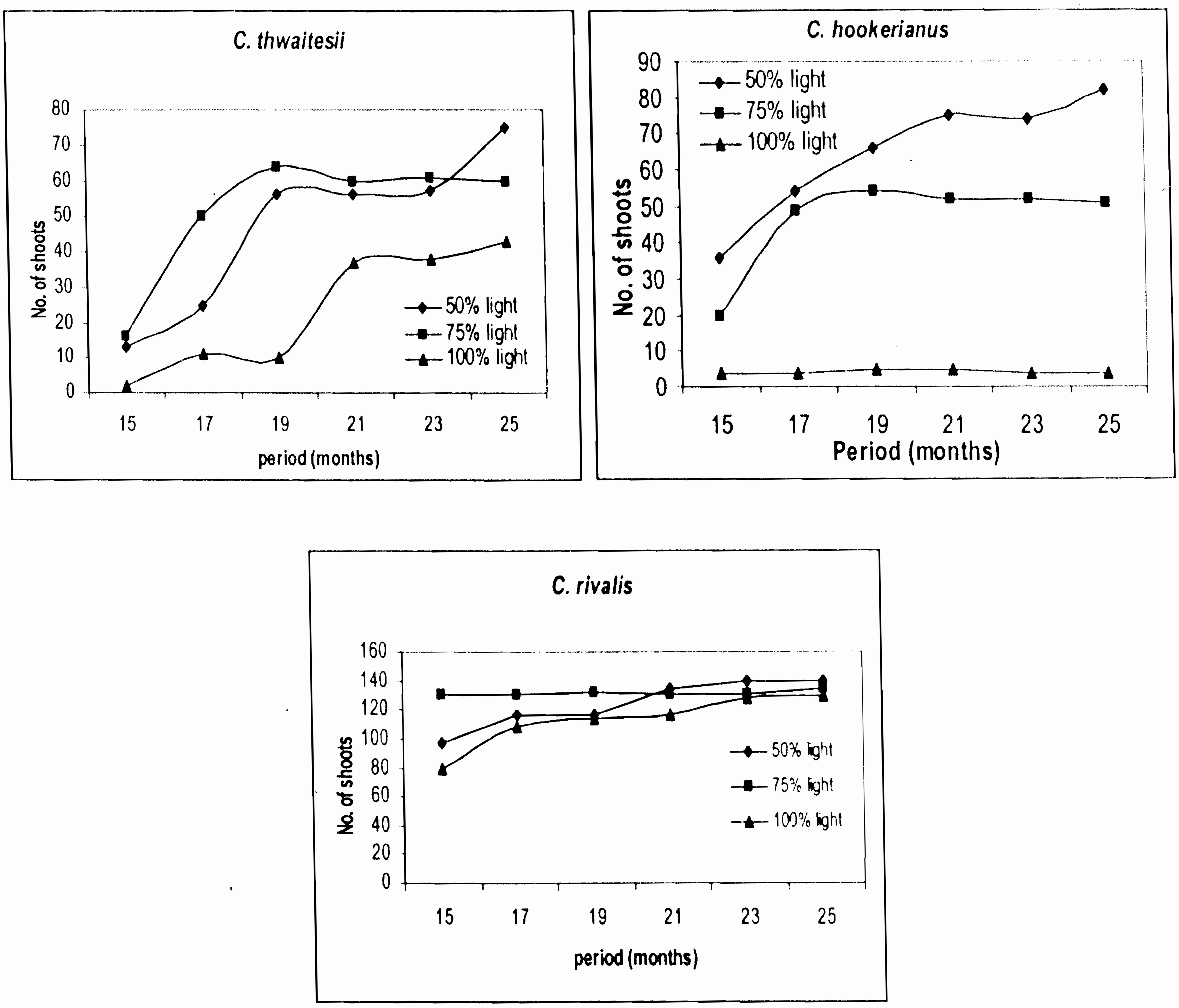


Fig. 6. Mean number of shoots produced in the three species under three different light intensities

Since the interaction between the species and period was found significant, the regression analysis was done for cumulative number of new shoots produced corresponding to different species and different light intensities (Tables 12,13). The adjusted R^2 was around 0.71 or more for all the three species indicating satisfactory fit of the models selected. The R^2 values were also found highly significant.

Table 12. Fitted equations for cumulative number of shoots for different species

Species	Regression Equation	Adjusted R^2
C. thwaitesii	$\sqrt{y} = -0.809+0.189t$	0.888
C. hookerianus	$\sqrt{y} = -0.317+0.153t$	0.816
C. rivalis	$\sqrt{y} = -0.729+0.276t$	0.707

Table 13. Fitted equations for cumulative number of for different shade

Light intensity (%)	Regression Equation	Adjusted R^2
50	$\sqrt{y} = -0.760+0.233t$	0.831
75	$\sqrt{y} = -0.545+0.217t$	0.747
100	$\sqrt{y} = -0.390+0.175t$	0.813

4.2.4 *Number of extractable shoots*

Extraction could be started in *C. rivalis* at 16th month after transplanting. An average of two shoots per plant could be extracted every two months. For the other two species, extraction could be started only from 20th month onwards (Table. 14).

Table 14. Number of shoots extracted

Species	Light %	November 2002	January 2003	March 2003	June 2003	August 2003	October 2003
C. hookerianus	50			39			
	75			19			
	100						
C. rivalis	50	5	21	91	46	34	81
	75	6	14	114	81	48	78
	100	26	19	43	48	43	74
C. thwaitesii	50			55			
	75			79	27	27	
	100						

4.3 Nutrient analysis

Nutrient analysis of five species, *C. tenuis, Calamus* species (Laos), *C. thwaitesii, C. hookerianus, and C. rivalis* was done. Table 15 presents the results of nutrient analysis of five species.

Crude protein

The crude protein in the fresh shoots ranges from 11.88 per cent in *C .hookerianus* to 18.13 per cent in *C. thwaitesii*. In *Calamus* species it is16.25 per cent and in *C. tenuis* it is 15 per cent. In *C. rivalis* the protein content is 14 per cent.

Fibre

The content of fibre ranged from 1.9 per cent in *C. tenuis* to 3 per cent in *C. hookerianus*. Among the W. Ghats species *C. rivalis* had the least fibre content, 2 per cent.

Moisture content

All the species were having a high percentage of moisture. *C. hookerianus* had 59.6 per cent while *C. thwaitesii*, 91.3 per cent. In other three species moisture content varied between 85 - 89.5 per cent.

Mineral nutrients

The percentage of phosphorus varied from 0.26 in *Calamus* species to 0.34 in *C. thwaitesii* and *C. hookerianus*. Potassium content was almost the same in all the species. Iron content was more in *C. rivalis*, 1.03 ppm. *C. hookerianus* had 0.55 ppm while in all other species it ranged from 0.18 to 0.32 ppm. Calcium content was high in all the species. *C. thwaitesii* registered the highest, 13.68 ppm followed by *C. rivalis* 8.29 ppm, *C. hookerianus* 7.39 ppm, *C. tenuis* 6.88 ppm and *Calamus* species 4.01 ppm. Magnesium content also was high. *C. hookerianus* was having 13.62 ppm, *C. rivalis*– 9.58 ppm, *Calamus* species. – 7.26 ppm, *C. tenuis* – 6.22 ppm and *C. thwaitesii*- 5.64 ppm

Table. 15. Chemical composition of edible rattan shoots collected from Kerala.

Sple. No	Names	Crude Protein %.	Crude Fibre %	Phosphorus %	Potassium %	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Pb (ppm)	Ca (ppm)	Mg (ppm)	Water %
		Dry samples											Fresh samples
1	*Calamus sp.* (Laos) (3 months)	16.25	2.00	.26	1.66	.18	.05	.28	.44	.04	4.01	7.26	87.80
2	*Calamus sp.* (Laos) (6 months)	10.63	4.00	.30	1.56	.23	.05	.27	.41	.06	8.75	10.60	87.30
3	*C. tenuis* (NE) (3 months)	15.00	1.90	.27	1.65	.17	.03	.18	.27	.05	6.88	6.22	86.30
4	*C. tenuis* (NE) (6 months)	07.81	3.80	.32	1.52	.23	.05	.27	.41	.06	8.75	10.60	81.60
5	*C.rotang* (3 months)	14.00	2.00	.30	1.67	.22	.05	1.03	.54	.07	8.92	9.58	88.50
6	*C.rotang* (6 Months)	10.63	4.00	.30	1.68	.33	.05	.42	.38	.16	8.85	9.63	87.50
7	*C.rotang* (1 Year)	10.63	4.30	.32	1.55	.23	.05	.27	.41	.06	8.75	10.60	88.00
8	*C.thwaitssi*	18.13	2.80	.34	1.84	.71	.05	.32	.40	.01	13.68	5.64	91.30
9	*C.hookerianus*	11.88	3.00	.34	1.82	.59	.08	.55	.69	.10	7.39	13.62	59.60
10	*C.metzianus*	8.00	3.50	.30	1.60	.23	.04	.40	.39	.08	7.53	8.24	89.00

4.4 *Comparison between different age groups*

Nutrient content was analysed at different age intervals, at three months and six months. For *C. rivalis,* shoots extracted from one year old plants also were analysed (Table 15). The protein content was at a higher level at three months. There is a considerable decrease in protein content in the shoots from six months old plants. In *Calamus* sps. it decreased from 16.25 per cent to 10.63 per cent, in *C. tenuis* from 15 per cent to 7.81 per cent and in *C. rivalis* from 14 per cent to 10.63 per cent. Fibre and phosphorus contents increased with age in all the three species. Mineral nutrients showed little or no variation with age.

4.5 Preservation of shoots

Rattan shoots are rather soft when compared to bamboo shoots. Shoots can be preserved in dried condition or in salt or sugar solutions.

4.5.1 *Drying process*

Leaf sheaths were removed with a knife until the soft white tissue inside was reached.

These shoots were cut into 4 cm pieces. Thick samples can be split into two or three pieces. The samples were boiled for 10 minutes in water containing 2 per cent sodium chloride, drained and spread on mats or trays and kept under the sunlight. Generally the samples take about three to four days to dry. This can be dried in an oven also at 70 ^{0}C. which will preserve the original texture and colour of the shoots.

4.5.2 *Preservation in solutions*

The shoot samples were cut into 8 cm pieces. Thick shoots can be split into two or three pieces. These pieces were boiled in water containing 0.1 per cent sodium meta bisulphate and again cooled to room temperature.

4.5.3 *Bottling*

The brine solution or sugary syrup was prepared. The brine solution contained 2 per cent sodium chloride, 0.5 per cent citric acid and 0.1 per cent calcium chloride. Syrup contained 30 per cent sucrose, 0.5 per cent citric acid and 0.1 per cent calcium chloride.

The processed shoots were put in suitable glass bottles filled with brine or sugar solution and placed the lid loosely. The bottles were steamed over boiling water for 15 minutes to remove the air from the bottle and closed the lid tightly. The bottles were cooled and stored at room temperature.

Three hundred 200 ml bottles of rattan shoots can be prepared out of 2000 rattan shoots. In dry method about 500 shoots are required to get 1 kg of dry shoots.

4.6 Cost-benefit analysis

A cost-benefit analysis was carried out and the Net Present Value (NPV), Benefit-Cost Ratio (BCR) at three discount rates of 6 per cent, 9 per cent and 12 per cent along with the Internal Rate of Return (IRR) are presented in the Table 1.

Table 1. Sensitivity analysis of cane species

Species	Discount rate						
	6%		9%		12%		IRR
	NPV	BCR	NPV	BCR	NPV	BCR	(%)
C. rivalis	41345	17.69	36920	16.89	33083	16.12	322.53
C. thwaitesii	16440	7.64	14617	7.29	13038	6.96	186.5
C. hookerianus	- 102	0.96	-197	0.91	-276	0.87	3.3

NPV- Net Present Value (in Rs)
BCR- Benefit Cost Ratio
IRR-Internal Rate of Return

Of the three species, *C. rivalis* and *C. thwaitesii* have positive NPV and the BCR is more than 1 at all the three discount rates. Besides, the IRR is also higher than the discount rates used indicating economic feasibility of the production of the species. At the same time for the species *C. hookerianus* the NPV is negative at the three discount rates and BCR is less than 1. Moreover, the IRR is less than the discount rate used indicating that the project on this species is not economically feasible introducing as an agricultural crop.

5. DISCUSSION AND CONCLUSION

Rattan shoot is used as a vegetable and consumed either as fresh or in preserved conditions in many Asian countries. In western countries it is mainly used as an ingredient in soup. In India even though rattan shoots are consumed in north eastern states, it is not common in southern regions. Only tribals use certain species for edible purpose. This project was taken up mainly to introduce some well known edible species to Kerala and to generate sufficient quantity of data with the Western Ghats species to support the introduction of rattan species for shoot production and to promote this idea among farmers.

Two common and preferred edible species were introduced, *C. tenuis* from northeast India and *Calamus* species from Lao PDR. Demonstration plots were established in two areas and data on shoot production was gathered. Three W. Ghats species were selected for detailed studies, *C. thwaitesii, C. hookerianus* and *C. rivalis*. To see whether these species can be promoted as an understorey crop experimental plots were laid out under three different light conditions and growth and production of new shoots were monitored. Nutrient contents were analysed for all the species studied.

5.1 Shoot production in introduced species

There was little or no harvest in the first year but after that the plants produced new shoots almost year round. If the plantation is raised as a monocrop, it may be possible to interplant an annual crop in the first year since the seedlings are planted with 1 m spacing. Once harvesting begins shoot production is rapid. Many shoots are present at any time, in different stages of development, and in each month those ready for extraction can be cut. In the present study, in *C. tenuis* and in *Calamus* sp. an average of one shoot per plant could be extracted during the season when production was at the maximum. The number decreased during other seasons. During summer season, April to June, the production was less. Gradually the production increased during the rainy season, and at Veluppadam maximum production was noticed during the period October to December reaching a maximum in January. At Nilambur the maximum production was noticed during the third quarter viz., from July to November so that the maximum number was obtained in October.

5.2 Studies on Western Ghats species

5.2.1 *Survival and growth*

Light intensity definitely has an effect on the survival percentage, growth and on the number of shoots produced on the three species as evidenced by the ANOVA (Tables 3, 6, 10). Under full sunlight all species registered low survival percentage and low rate of growth. In *C. hookerianus* maximum survival was seen under 75 per cent light. In *C. thwaitesii* and *C. rivalis* the maximum survival was under 50 per cent light. In case of growth in height, *C. thwaitesii and C. rivalis* performed well under 75 per cent light whereas in *C. hookerianus* the growth rate was maximum under 50 per cent light. The number of shoots produced was greater under 50 per cent light in all the species. Hence these species can be promoted as understorey crops.

5.2.2 *Nutritional status*

In general the rattan species studied contain a considerable amount of protein. Among mineral nutrients, calcium, iron and magnesium contents are higher which are important elements in human metabolic activities. A similar observation was reported for the Thai rattans also (Heamakarn, 2000). Xu *et al.* 1991 reported a high percentage of protein from two species of Chinese rattans, *Daemonorops margaritae* and *Calamus simplicifolius*. They reported that the content of total proteins in the fresh shoots of *C. simplicifolius* was higher than the average content of total proteins in 12 kinds of vegetables (1.45 %) and 27 kinds of bamboo shoots (2.65 %) while that of *D. margaritae* is higher than the average content of vegetables and lower than the average in bamboo shoots. Percentages of calcium and zinc were also high in these two species.

5.3 Comparison of nutrient contents with other palm shoots (Palm hearts)

A comparison was done with the data available on the nutrient status of other palm hearts (Table 16). Protein content is considerably higher in rattans which varies between 11.88 and 18.13 per cent depending on the species. The average protein content reported in *Cocos nucifera* is 13.2 per cent. Hence rattans can be considered as a good protein source. Fibre content is lesser when compared to other palm hearts and hence more palatable.

Calcium and iron contents also are higher in rattans. *C. rivalis* has 1.03 ppm of iron while in other rattan species it ranged from 0.28 to 0.55 ppm. Only a very low amount of iron has been reported from other palms, ie., 0.003 and 0.009 ppm in *Cocos nucifera* and *Arenga pinnata* respectively. In case of calcium, *C .thwaitesii* registered 13.68 ppm, *C. rivalis* - 8.52 ppm, *C. hookerianus* - 7.39 ppm and *C. tenuis,* 4.01 ppm whereas only 0.2 ppm is reported in *Cocos*, 0.6 ppm in *Borassus* and 0.4 ppm in *Arenga* .

Table 16. Comparison of nutrient values with other palm shoots and leafy vegetables

Names	Protein %.	Fibre %	Phosphorus %	Iron(ppm)	Calcium(ppm)
C. thwaitesii	18.1300	2.8000	0.3400	0.3200	13.6800
C. tenuis	16.2500	2.0000	0.2600	0.2800	4.0100
C. rivalis	14.0000	2.0000	0.3000	1.0300	8.9200
C. hookerianus	11.8800	3.0000	0.3400	0.5500	7.3900
C. metzianus	8.0000	3.5000	0.3000	0.4000	7.5300
Other palms					
Cocos nucifera	13.2000	7.4000	0.4400	0.0037	0.2000
Borassus flabellifer	8.9000	7.2000	0.4600		0.6000
Arenga pinnata	1.9000	9.4000	0.0560	0.0090	0.4000
Leafy vegetables					
Amaranthus	4.9000		0.1000	0.0210	0.0005
Cabbage	1.8000	1.0000	0.0440	0.0008	0.0400
Boerhavia diffusa	6.1000		0.0990	0.0180	0.7000

Source:--Wealth of India, 1948-1976; Manju Sundriyal and R.C. Sundriyal, 2001

5.4 Comparison of nutrient contents with other leafy vegetables

When compared to other leafy vegetables also, the protein content is higher in rattans (Table 16). *Amaranthus* has only 4.9 per cent, *Boerhaavia*- 6.1 per cent and cabbage- 1.8 per cent while in rattans it ranges from 11.8 per cent to 18.15 per cent. Fibre content is more in rattans. Phosphorus content also is more in rattans. Here also iron and calcium are considerably higher than the leafy vegetables.

5.5 Comparison of the W. Ghats species with introduced species

C. tenuis and *Calamus* sp. are considered to be good edible species. These are the preferred species in north eastern states and Lao PDR respectively. Hence the nutrient status of W.Ghat species was compared with these two species.

5.5.1 *Protein*

Protein content is higher in *C. thwaitesii* (18.13 %) when compared to the introduced species (15 - 16.25 %). *C. rivalis* has 14 per cent and *C. hookerianus* has only 11.8 per cent.

5.5.2 Fibre

W. Ghats species, except *C. rivalis,* show more fibre content (3 %). *C. rivalis* equals with that of introduced species. Hence *C. rivalis* will be more palatable than *C. thwaitesii* and *C. hookerianus.*

5.5.3 *Moisture content*

C. thwaitesii has more moisture content (91.3 %) and *C. hookerianus*, the least (59.6 %). *C. tenuis* and *Calamus* sp. have slightly lesser moisture content than *C. thwaitesii*, about 86 - 87 per cent. The high moisture content will reduce the storage period in fresh condition. Hence soon after collection the shoots should be subjected to preservative treatments.

5.5.4 *Mineral nutrients*

Percentage of phosphorus, potassium, copper and lead are almost the same in all species. *C. thwaitesii* and *C. hookerianus* have slightly higher percentage of zinc (0.71 ppm & 0.59 ppm). Manganese content is more in *C. hookerianus* and *C. rivals* (0.69 ppm & 0.54 ppm). Iron content is considerably higher in *C. rivalis.* Calcium content is more in *C. thwaitesii. C .rivalis* and *C. hookerianus* also have higher quantity of calcium (8.92 ppm & 7.39 ppm) while that of introduced species ranges from 4.01 ppm to 6.88 ppm . *C. hookeianus* contains a higher amount of magnesium (13.62 ppm) followed by *C. rivalis* (9.58 ppm). In the introduced species it ranges from 6.2 ppm to 7.2 ppm. *C. thwaitesii* shows a lower value, 5.64 ppm.
Hence the W. Ghats species equals with *C. tenuis* and *Calamus* species in their nutrient contents. Some of the mineral nutrients are slightly more in W. Ghat species.

5.6 The changes in nutrient composition at different ages.

The fibre content increases with age while other nutrient contents decrease. Three-months-old shoots are best suited for consumption. A similar observation was reported by Hu (1987) in bamboo shoots also.

5.7 Preservation

Rattan shoots can be preserved either in dry condition or in salt or sugar solutions. Three hundred 200 ml bottles of rattan shoots can be prepared out of 2000 rattan shoots. In dry method about 500 shoots are required to get 1kg of dry shoots.

5.8 Cost-benefit analysis

Of the three species, *C. rivalis* and *C. thwaitesii* were found to be economically feasible for introducing as agro-forestry crops. Hence these two species can be promoted among farmers in the Western Ghats for getting an alternative income.

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