STUDIES ON THE EFFECT OF SLASH BURNING ON PLANTING SITE FOR TEAK

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ABSTRACT

An extensive field trial was conducted at Mundakadavu of Karulai Rang; in Nilambur Forest Division during 1981-'85 to study the effect of slash burning on soil properties, weed growth, taungya yield and growth of teak *(Tectona grandis* L. f) in a second rotation plantation. The study lead to the following conclusions. Burning caused significant enhancement of base content and change in soil reaction from acidic to alkaline. These effects were short-lived and within six months the soil had the same reaction and base content as at the start of the experiment. Though burning reduced weed growth during the first three months after planting, the difference was not significant subsequently. The yield of paddy *(Oryza sativa* L.), the first taungya crop, was not influenced by the treatments. None of the treatments had significant influence on survival of teak. The treatment effect on height of teak, though noticed during the first three years, was not significant afterwards. Salvaging firewood between 10-30 cm girth over bark (which would have otherwise been burned) yielded a net revenue of Rs. 756 per hectare in 1982 after meeting the labour charges of Rs. 1244. As slash burning did not have lasting influence either on the growth of teak or on soil properties, a modification in the current practice is suggested. Ail wood down to 10cm girth over bark - the lower limit up to which firewood collection may be commercially viable - could be marketed and the rest either burned (resulting in a light slash burning) or left at site (to deteriorate over time) depending on local conditions.

Key words : Slash burning, Taungya, Weed biomass, Soil properties, Teak growth

1. INTRODUCTION

Ground preparation, to a great extent, decides the successful establishment of a plantation. In areas subjected to clearance of tree growth, it involves removal of debris or slash material, the disposal of which may be essential for further plantation works and is often the most costly silvicultural operation. In a second or subsequent rotation teak plantation, it accounts for about 60% (Appendix I) of the initial establishment cost.

Slash burning is a practice primarily intended for disposal of debris, resulting from logging, prior to plantation establishment. Burning is cheap; it greatety improves access, the resulting layer of ash enhances base nutrients and vermins are often killed. The disadvantages of clearance by burning are the risk of fire getting out of control or flaring up from smouldering debris even days afterwards, restriction of its use to certain days, the variability of result depending on conditions, loss of organic matter and possibly nitrogen from the ecosystem and the risk of fungal infection (Evans, 1982).

Very little data are available on the effect of slash burning on regeneration in tropical countries. Most of the works were on soil itself and often confined to the laboratory. The effect on the growth of the subsequent regeneration has often been taken for granted.

The practice of burning before artificial regeneration is largely confined to the moist deciduous and semievergreen types of forest, where the actual regeneration is relatively easy and the burn, although not essential, is largely used to clear away the debris and discourage early weed growth. It is in these types (in particular) that the effect of the burn has been taken for granted (Griffith, 1946).

In one of the earlier burning experiments in a second rotation teak plantation in Nilambur, teak was reported to have grown better during the first year. In another experiment in Java where teak was raised in a burned plot in conjunction with rice and maize, the height growth of teak was reported to be 62% and 33% greater in the first and second year respectively compared to those in the unburned plots. The yield of rice and maize was also 40% greater in burned plots. (Coster, 1932). However, in a series of experiments in the evergreen forests of the Southern India, burning did not improve height growth of seedlings (Griffith, 1937-'38). Meanwhile, the experiments conducted at Dehra Dun indicated substantial increase in growth of most of the species during the first year and to a lesser extent in the second year (Griffith, 1946).

In a study conducted in Karulai Range of Nilambur, Siidheendrakumar and Chacko (1986) found that slash burning had no significant impact on termite infestation at the plantation site.

However, adequate information on the effect of different intensities of burning on establishment and growth of teak plantation is lacking. Thus this study was aimed at finding out whether slash burning was necessary at all or if so, to evolve a practice of slash burning agreeable with respect to growth of teak, soil properties. weed growth and fuelwood supply.

2. MATERIALS AND METHODS

2.1. *Study area*

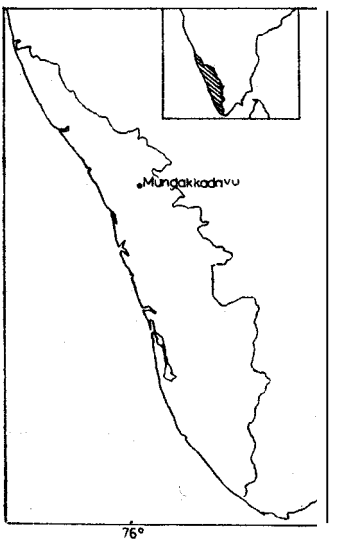

Fig. 1. Location of study area

The study was undertaken in a 1982 teak regeneration area at Mundakadavu ($11^{0}18'$N $76^{0}22'$E) in Karulai Range of Nilambur Forest Division (Fig. 1). The experimental plots covering 7.6ha were located within the 24.75ha regeneration area (Fig. 2). A 55 year old teak plantation with an average stand density of 128 trees per hectare formed the original stand. Details of soil profile are given in Table 1. The average site quality of the experimental area was determined as 2.0 II to 1.0 I by measuring height of 10 dominant trees per hectare and reading the corresponding site quality from the yield table. The terrain was flat to gently sloping.

Table 1. Soil properties (profile) of the experimental area

Depth cm	Gravel %	Sand %	Silt+Clay %	pH	Organic Carbon	Exchange Acidity	Exchangeable bases
						.....me / 100g	
00-16	12	85	15	6.2	1.1	3	16
16-37	25	82	18	6.1	0.8	2	14
37-82	20	79	21	6.3	0.7	2	11
82-101	22	80	20	6.1	0.6	2	12
101-120	16	73	27	6.2	0.5	2	11

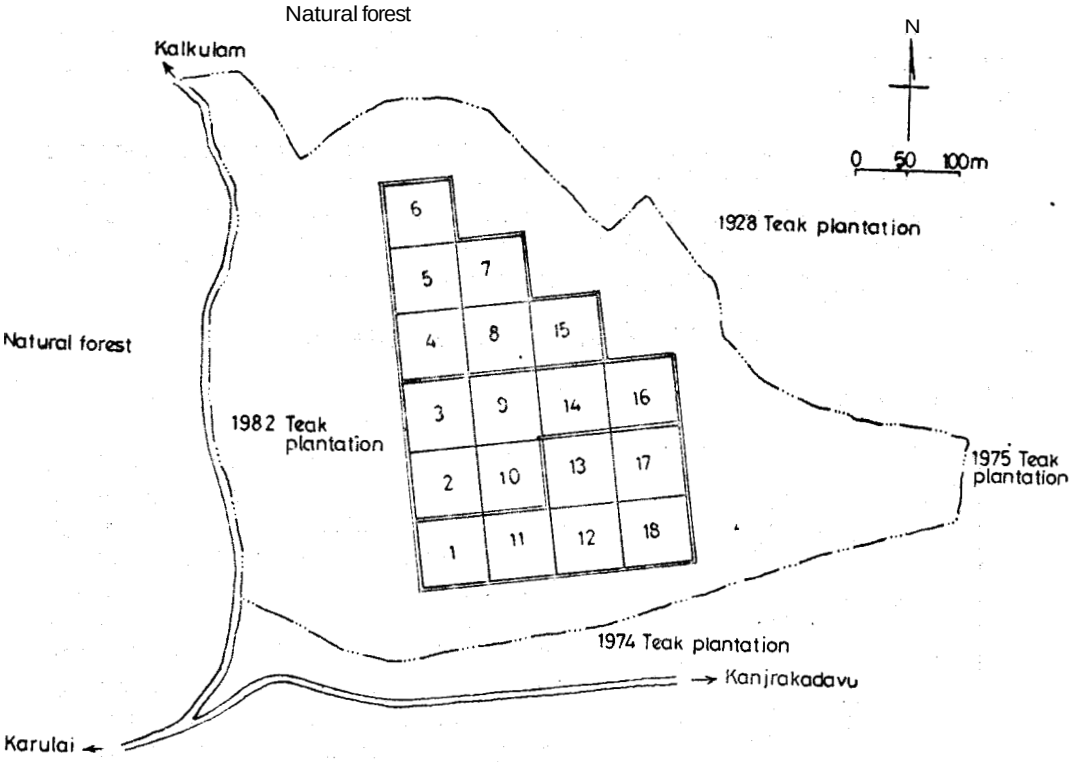

Fig. 2. Experimental layout

	Treatment	Replication - wise allotment of treatment plots		
		R_1	R_2	R_3
A	Burning all material less than 30 cm g.o.b (girth over bark) and teak raised under taungya	17	9	6
B	Burning all material less than 10cm g.o.b and teak raised under taungya	13	2	15
C	Material less than 10cm g.o.b left at site unburned and teak raised under taungya	1	3	7
D	Treatment A without taungya	12	14	8
E	Treatment B without taungya	18	16	4
F	Treatment C without taungya	11	10	5

The area received an average annual rainfall of 2375 mm during the study period (Table 2 and Fig. 9) and the mean annual minimum and maximum temperatures varied between 17° and 37°C.

Table 2. Rainfall (mm) during the study period

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1981	Nil	Nil	Nil	45(4)	108(4)	71!(26)	640(19)	852(27)	354(19)	219(12)	64(6)	9(1)	3002(118)
1982	Nil	Nil	Nil	4(1)	53(7)	339(19)	527(22)	284(19)	58(4)	16(6)	105(10)	Nil	1386(88)
1983	Nil	Nil	Nil	Nil	59(8)	1245(20)	324(21)	604(21)	358(20)	162(11)	40(2)	67(5)	2859(108)
1984	14(4)	16(4)	28(5)	34(9)	69(5)	1009(28)	658(26)	230(24)	128(17)	412(16)	26(5)	26(1)	2648(144)
1985	lS(2)	l(1)	9(1)	50(4)	45(12)	762(30)	454(29)	298(27)	115(16)	114(12)	109(5)	5(2)	1981(141)
												Average	2375(120)

Figures in parenthesis indicate number of rainy days

Lay out

Randornised Block Design (RBD) was employed for the layout of the plot. In all, there were 6 treatments replicated thrice.

Treatments

A Burning all material less than 30 cm girth over bark (4.7kg m^{-2}) and teak raised under taungya.

B Burning all material less than 10 cm girth over bark (1.9kg m^{-2}) and teak raised under taungya.

C Material less than 10 cm girth over bark (1.9kg m^{-2}) left at site unburned and teak raised under taungya.

D Treatment A without taungya

E Treatment B without taungya

F Treatment C without taungya

Plots measuring (65 x 65m) were demarcated on the ground by trenches and cairns at the corners and a 2 m inspection path around. In spite of the care taken in site selection. two treatments (C and F) in replicate 3 had to be rejected as those plots were found waterlogged during the first rainy season.

2.4. *Tree felling and* slash *burning*

The trees in all the plots and surround were felled during October 1981 and converted into logs and billets. All the material of and above 30 cm girth over bark (g.o.b) were removed from the site. The remaining slash material was evenly distributed (Fig 3). In treatments B, C, E and F, wood down to 10 cm g.o.b was collected, stacked (Fig. 4) and subsequently sold in public auction.

Fig. 3. Slash distributed for burning

After evenly distributing the slash material in the treatment plots the quantity was estimated by weighing samples, sample plots of 6.5 x 6.5 m collected from (1% sampling). The plots under full burning (A&B) contained 4.7 kg m^{-2} of slash material while the treatments under partial slash burning (B& E) and no burning (C & F) had 1.9 kg m^{-2} of the same. The burning was carried out (Fig. 5) in March 1982.

2.5. Teak planting

Fresh teak *(Tectona grandis* L. f.) stumps prepared from one year old nursery seedlings were planted in all the treatment plots and the surround at 2x2 m spacing during May 1982. Each treatment plot had 1000 plants of which 100(10%) were marked for observation along 4 lines of 25 each running through

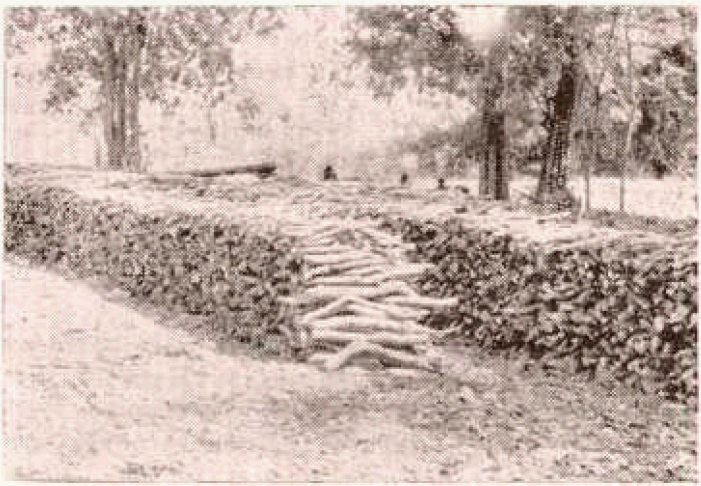

Fig. 4. Wood salvaged through reduction/elimination of slash burning

Fig. **5.** Slash burning in progress

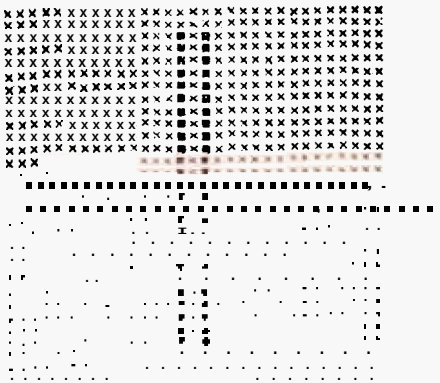

Fig. **6.** height of teak.

x Planting point

◈ Observation plant

the centre (Fig.6) except in plots 1 and 11 where the plants for observation had to be restricted to the portion of the plot unaffected by accidental fire. All casualties were replaced within the first month. The plots were protected from fire, grazing and wild animals, Regular observations on survival and height were taken nine times for a period of 42 months and data statistically analysed. Missing values for the treatments in replicate 3 were estimated. The treatments were identified as main plots and repeated measurements overtime were identified as subplots for analysis of both survival and height (Gomez and Gomez, 1984). Angular transformation for survival and log transformation for height were done before analysis.

2.6 *Taungya*

Treatment plots A, B and C were leased out for taungya (agrisilvi-cultural practice) in the first year to raise one crop of paddy *(Oryza sativa* L.) followed by another crop gingelly *(Sesamum indicum* L,).

The paddy ('Padannavella', a local variety) was broadcast sown and the soil worked to a depth of 3-4 cm by the taungyadar (lessee) during June 1982. All weeds were uprooted and gathered either on the boundaries or on stumps of the felled trees. The labour employed for various works connected with sowing paddy was recorded. The plots were again weeded during the end of July 1982 and urea applied @ 45 kg per hectare. The crop was harvested after 3.5 months in September 1982. Three samples, 4 m^2 each, were taken from each plot and the yield of paddy and straw determined treatment-wise. The missing values in replicate 3 were estimated and the data subjected to analysis of variance.

The taungyadar raised the second crop (gingelly) during October 1982 to January 1983. The yield data could not be collected from all the plots.

Fig. 7 Teak with taungya (tapioca)

In treatments A, B & C, tapioca *(Manihot esculenta* Crantz) was raised (Fig. 7) in the second year during September 1983 to March 1984. The stem cuttings were planted on soil mounds formed in between four teak plants with the same spacing as that of teak. As the attempt to lease out the area could not materialise, the tapioca cultivation was undertaken by the Institute. The yield data from treatments B and C only could be collected.

2.7 *Weed growth*

All the treatment plots without taungya (D, E & F) were kept weeded as under.

Time of weeding		*Type of weeding*
	1982 June	i) Scrape weeding around individual plant to a diameter 60 cm.
		ii) Clear knife weeding
	August	Clear knife weeding
	October	i) Scrape weeding around individual plant to a diameter of 60 cm.
		ii) Clear knife weeding
	,, November	Clear knife weeding
	1983 January	Clear knife weeding
II year	,, July	i) Scrape weeding around individual plant to a diameter of 60 cm
		ii) Clear knife weeding
	,, September	Clear knife weeding
	,, November	do
III year	1984 August	do
	,, January	do

The above weeding schedule was uniformly administered in all the non-taungya plots (Fig. 8). Weed samples were collected from 3 sample subplots of 1 x I m in each treatment plot at random 4 times in the first year, 3 times in the second year and 2 times in the third year. There were 9 such sample plots for each treatment. The samples were oven dried and biomass determined. The data were subjected to analysis of variance after estimation of missing values in two treatments in replicate 3.

Fig. 8. Teak without taungya

2.8 *Soil studies*

Soil samples were collected at numerous places from the 0-15 cm layer in each plot and composited. The sampling times were:

1. Before burning (January 1982) 2. After burning (March 1982). 3. After paddy cropping (September 1982). 4. After gingelly cropping (January 1983) and 5. After tapioca harvesting (March 1984).

Samples were air-dried. passed through a *2* mm sieve and analysed for pH (1:2 soil-water), organic carbon and exchangeable bases following standard procedures (Jackson, 1973). The data were subjected to a two way analysis of variance for the factorial structure of treatments.

3. RESULTS AND DISCUSSION

3. 1. *Firewood salvaged*

The particulars of material salvaged from treatments B. C, E & F are presented in Table 3.

Table 3. Details of firewood (10-30 cm girth over bark) salvaged from the 12 plots (5.07 hectare) under treatments **B,** *C,* E, *&* F.

Species	No. of stacks (1 stack=2xlxl m)	Expenditure for collection and transportation to depot (Rupees)	Revenue obtained through public auction (Rupees)	Net revenue (4-3) (Rupees)	Net revenue per hectare (Rupees)
1	2	3	4	5	6
Teak	102.0	5207.40	6890.00	1682 60	331.87
Miscellaneous	21.5	1097.65	3246.50	2148.85	423.84
Total	123.50	6305.05	10.136.50	3831.45	755.71

Generation of labour, additional revenue and supply of firewood to the market were the benefits derived through salvaging a part of the firewood which would have otherwise been burned.

3.2. Soil properties

3.2.1. *pH* - The dynamics of soil pH in different treatments is given in Table 4. There was a sharp increase in soil pH immediately after burning. The slightly acid soil before burning (pH 6.2-6.5) turned to neutral or mildly alkaline (pH 7.2-7.6) This alkaline reaction was quite short-lived and within a span of 6 months the burned plots had acidic soil reaction (6.1-6.5). Further significant changes were not observed during the course of experiment. Two years after burning, the soils had nearly the same pH as at the start of the trial, with taungya imparting no influence at all.

Table 4. Soil pH

Treatment	Sampling time				
	February 1982	March 1982	September 1982	January 1983	March 1984
A	6.36[a]	7.46[b]	6.29[a]	6.36[a]	6.12[a]
B	6.49[a]	7.23[b]	6.46[a]	6.40[a]	6.21[a]
C	6.22[a]	6.22[a]	6.19[a]	6.16[a]	6.22[a]
D	6.25[a]	7.63[b]	6.51[a]	6.39[a]	6.37[a]
E	6.26[a]	7.38[b]	6.54[a]	6.38[a]	6.30[a]
F	6.27[a]	6.27[a]	6.10[a]	6.10[a]	6.20[a]

Figures superscribed by the same letter in a column are not significantly different from each other at P = 0.05.

3.2.2. *Exchangeable bases* - The same trend as with pH was seen in the case of exchangeable bases too (Table 5). 'There was sharp increase in the quantum of exchangeable bases in the soil immediately after burning. Within a period of six months, the level of bases dropped to that prior to burning. Further, during the experiment, soils of different plots had slightly varying base levels (17-23 meq/100mg), the difference remaining statistically not significant.

Table 5. Exchangeable bases meq/100g

Treatment	Sampling time				
	February 1982	March 1982	September 1982	January 1983	March 1984
A	19.0[a]	42.0[b]	18.0[a]	18.7[a]	17.3[a]
B	21.0[a]	38.7[b]	19.0[a]	19.3[a]	19.0[a]
C	17.0[a]	17.0[a]	20.0[a]	18.0[a]	17.0[a]
D	19.5[a]	63.5[c]	22.0[a]	21.3[a]	20.7[a]
E	20.0[a]	50.0[b]	19.0[a]	19.7[a]	18.0[a]
F	21.0[a]	21.0[a]	19.0[a]	19.7[a]	23.0[a]

Figures superscribed by the same letter in a column are not significantly different from each other at P=0.05.

3.2.3. *Organic carbon* - The results given in Table 6 shows that burning did not have an impact on the organic carbon of the soil. The different treatments too did not provide for variation in carbon content.

Table 6. Organic carbon %

Treatment	Sampling time				
	February 1982	March 1982	September 1982	January 1983	March 1984
A	1.52	1.43	1.51	1.44	1.31
B	1.87	1.75	1.74	1.64	1.65
C	1.47	1.47	1.64	1.71	1.58
D	1.67	1.49	1.70	1.69	1.91
E	1.47	1.56	1.46	1.47	1.50
F	1.77	1.77	1.71	1.86	1.84

Figures in a column are not significantly different from each other at $P = 0.05$

Slash burning released nutrients from the slash to the mineral soil. But this resulted only in a temporary increase in soil pH and bases. Further loss of nutrients from the site either through leaching or uptake by plants, apparently, took place and the effect of burning could not be observed within a short time after burning (Kraerner and Herman, 1979; Mroz *et a/.,* 1980). Rashid (1987) reported more prolonged effect of fire on soils from Algeria and this might be due to the area being quite dry when compared to the experimental site at Nilambur. Higher rainfall might have been responsible for neutralising the effect of burning within a shorter period. As plots were protected from fire, further reduction in fertility was prevented. The absence of an effect of fire on organic carbon status of soil en due to parts of the vegetation getting mixed with the soil (Nye an dGreenland ,1960 and 1964). The practice of agrisilviculture, incorporated into the trial also did not induce significant changes in soil properties. This may be attributed to the flat terrain of the experimental site, while changes in soil properties due to taungya with tuberous crops like cassava on slopes have been reported (Alexander *et a/.,* 1980).

3.3. *Weed growth*

Species that formed the weed growth were *Helicteres isora* L.. *Chromolaena odorata* (L). King *ex* Robins *(Eupatorium odoratum* L,.), *Strychnos nux-vomica* L,. *Ziziphus* sp., grasses etc. Quantitative details of weeds, at different time periods are presented in Table 7. Except for the first weeding in June 1982, weed growth was the same in all the treatments D, E and F throughout the study period. During June 1982, the treatment F (no burning) had almost double the biomass compared to D and E eventhough the height of weeds was the same in all the treatments.

Table 7. Mean height of dominant species and biomass of undergrowth (weeds) in different non-taungya treatments during different periods of knife weeding. (The figures correspond to weed growth between consecutive weeding)

Treatment	Parameter	First year				Second year			Third year	
		Jun82	Aug82	Nov82	Jan83	Jul 83	Sep 83	Nov 83	Aug 84	Jan 85
D	Height (cm)	82[a]	98[a]	131[b]*	62[b]*	103[a]	114[a]	111[a]	188[a]	185[a]
	Biomass(kg ha^{-1})	1743[b]**	8707[a]	5600[a]	2997*	2473[a]	3630[a]	3010[a]	4850[a]	3933[a]
E	Height (cm)	93[a]	115[a]	115[a]*	48[a]*	99[a]	112[a]	120[a]	186[a]	195[a]
	Biomass(kg ha^{-1})	1383[a]**	10863[a]	5137[a]	2747[a]	267[a7]	3530[a]	4073[a]	3327[a]	3280[a]
F	Height (cm)	83[a]	106[a]	143[b]*	59[b]*	102[a]	117[a]	129[a]	182[a]	180[a]
	Biomass(kg ha^{-1})	3180[c]**	9440[a]	5810[a]	2673[a]	2767[a]	4047[a]	3887[a]	6083[a]	2333[a]

Figures superscribed by the same letter in a column for a character are not significantly different at P = 0.01**; P =

The-above finding brought out the fact that the effect of slash burning in keeping down weed growth was only short term and not pronounced beyond three months.

3.4. *Taungya crop*

The lease amount obtained for various treatment plots (Table. 8) probably reflects the uncertainity in the minds of the taungyadars who took part in the lease auction regarding the success of taungya without a good burn and also to some extent the extra expenditure that was foreseen in preparing the site for sowing.

Table 8. Average lease amount obtained in public auction held on 6.4.82 for different treatment plots for raising two taungya crops (Paddy and Gingelly)

Treatment	Plots	Amount of lease per hectare (Rs)	Remarks
A	6, 9, 17	1617	
B	2, 13, 15	868	A:B:C = 100:54:25
C	1. 3,7	403	

The particulars of labour employed for preparation of site in connection with sowing is presented in Table 9. Compared to treatments A & B where burning was carried out, the expenditure incurred in C for sowing paddy was about 35% more. This additional labour was required for removal of the debris to convenient places within the plot prior to sowing.

Table 9. Comparative statement of labour engaged for sowing paddy during June-July 1982.

Treatment	Average mandays* per hectare	Remarks
A	46.72	
B	45.40	A:B:C = 100:97:136
C	63.34	

*1 manday 7 man hours + 1 hour interval

The harvest particulars of 3 taungya crops, the first two in the first year and the third in the second year, are presented in Tables 10, 11 and 12. The difference in grain yield and straw yield in different treatments in the case of paddy was not significant (Table 10).

Table 10. Harvest particulars of first taungya crop - Paddy *(Oryza sativa* L.) var. 'Padannavella'

Treatment	Mean height of crop at harvest cm	Grain yield kg ha^{-1}	Straw yield	
			Fresh weight kg ha^{-1}	Sun dry weight kg ha^{-1}
A	122	3210	8915	5143
B	123	3558	8920	6623
C	120	3678	7780	4680

Figures in a column are not significantiy different at P=0.05

Yield figures for second (Table 11) and third (Table 12) taungya crops could not be subjected to statistical analysis for want of data from all plots. However, the results do not give any indication of the advantage of burning in crop production.

Table 11. Harvest particulars of second taungya crop - Gingelly *(Sesamum indicum* L.)

Treatment	Mean height of crop at harvest cm	Seed yield kg ha^{-1}	Remarks
A	124	768	only from replicates 1 & 2
B	143	388	only from replicate 2
C	138	738	only from replicate 3

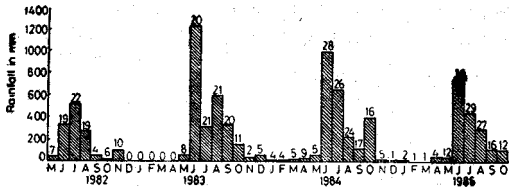

Fig. 9 Monthly rainfall for 1982-'85 (Figure on bar indicates number of rainy days)

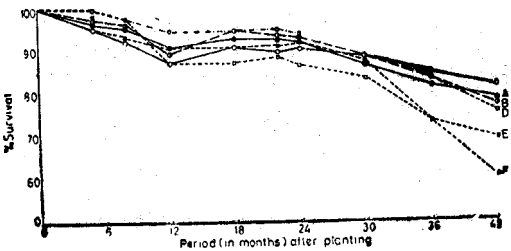

Fig. 10 Percentage survival of teak in different treatments during the study period.

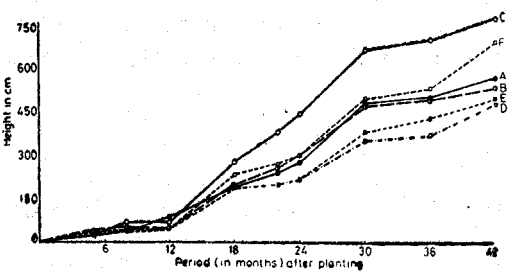

Fig. 11 Height growth of teak in different treatments during the study period.

A Burning all material less than 30 cm g.o.b (girth over bark) and teak raised under taungya.

B Burning all material less than 10 cm g o.b and teak raised undertaungya.

C Material less than 10 cm g.o.b left at site unburned and teak raised under taungya.

D Treatment A without taungya

E Treatment B without taungya

F Treatment C without taungya

Table 12. Harvest particulars of third taungya crop - Tapioca *(Manihot esculenta* Crantz)

Treatment	Mean height of crop at harvest cm	Tuber yield kg ha^{-1}	Remarks
A	Not available	Not available	Nil
B	310	12393	from all replicates
C	361	14625	only from replicates 1 & 2

3.5. *Survival and height growth of teak*

3.5.1. *Survival*

Survival of teak during the study period is presented in Table 13 and Fig. 10. The difference in survival percentage between treatments was not statistically significant at $P = 0.05$.

Table 13. Mean survival percentage in different treatments at various periods after planting.

Treatment	Mean % survival at different periods (months)									
	0	5	8	12	18	22	24	30	36	42
A	100	96	95	90	92+	92	91	86	81	78
B	100	97	96	89	94+	93	92	86	83	77
C	100	95	92	87	90+	89	90+	88	84	81
D	100	98	97	94	94	94	93	88	83	75
E	100	95	93	90	90	91+	91	87	73	69
F	100	99	97	87	87	88	86	83	73	60

Figures in a column are not significantly different at P=0.05

The increase is due *to* emergence of sprouts from the stumps recorded as casualties earlier.

3.5.2. *Height growth*

The mean height of teak in different treatments is given in Table 14 and Fig. 11. Statistical analysis did not proclaim the observed differences between the six treatments as significant at P=0.01 at any of the time points during the 42 months of observation.

Table 14. Mean height of teak in different treatments at various periods after planting.

Treat-ment	Mean height (cm) at different period (months)									
	0	5	8	12	18	22	24	30	36	42
A	0	26^{a}	44^{a}	47^{a}	189^{a}	238^{a}	280^{a}	479^{b}	504^{b}	570^{a}
B	0	27^{a}	44^{a}	45^{a}	194^{a}	256^{a}	300^{a}	471^{ab}	488^{b}	530^{a}
C	0	29^{a}	65^{a}	64^{a}	277^{a}	385b	442^{b}	.661^{b}	698^{b}	770^{a}
D	0	38^{b}	53^{a}	48^{a}	185^{a}	200^{a}	217^{a}	351^{a}	364^{a}	477^{a}
E	0	31^{a}	43^{a}	41^{a}	187^{a}	206^{a}	220^{a}	378^{a}	425^{ab}	497^{a}
F	0	28^{a}	35^{a}	37^{a}	230^{a}	270^{a}	291^{b}	492^{b}	523^{b}	688^{a}

The figures superscribed by the same letter in a column are not significantly different at P=0.05; CV (in log scale) = 2.07%.

However at P = 0.05, treatment D registered maximum height during the initial 5 months and this difference was significant compared to all the other treatments. During 8 to 12 months, the treatment D was relegated to the second position. Simultaneously C took over the first place and maintained that till the close of the study. Though the ranking by height values among treatments changed several times, the variation in height growth became non significant by 42nd month indicating short term effect of various treatments.

In all the treatments there was an increase in Current Annual Height Increment (CAHI) and Mean Annual Height Increment (MAHI) in the first two years (Tables 15 & 16). The MAHI showed increase in the third year whereas the CAHI showed decline and the growth pattern was the same in all treatments.

Table 15. Current annual height increment (cm) in different treatments during the first three years.

Treatment	First year	Second year	Third year
A	47	233	224
B	45	255	188
C	64	378	256
D	48	169	147
E	41	179	205
F	37	254	232

Table 16. Mean annual height increment (cm) in different treaments during the first three years.

Treatments	First year	Second year	Third year
A	47	140	168
B	45	150	163
C	64	221	233
D	48	109	121
E	41	110	142
F	37	146	174

4. CONCLUSION

4.1. Slash burning, a practice prirnarily intented for disposal of debris resulting from logging operations prior to establishment of a plantation, did not show prolonged impact on soils. Burning caused significant enhancement of base content and change in soil reaction from acidic to alkaline. These effects were short-lived and within six months the soil had the same reaction and base content as at the start of the treatment.

4.2. The low lease amount obtained for the taungya plots which were unburned and burned with less slash was not commensurate with the extra labour involved and the yield obtained. The increase in labour was only about 35% as against 75% reduction in lease amount. Yield of paddy *(Oryza sativa* L.), the first taungya crop, was not influenced by burning.

4.3. Though burning reduced weed growth in the non-taungya plots during the first three months after planting, the difference was not significant subsequently.

4.4. None of the treatments had significant influence on survival of teak.

4.5. During the initial three years the treatment without burning and taungya registered better height growth. but beyond this period the difference was not significant.

4.6. Salvaging firewood between 10-30 cm girth over bark (which would have otherwise been burned) yielded a net revenue of Rs. 756 per hectare in 1982 after meeting the labour charge of Rs. 1244.

5. RECOMMENDATION

As slash burning does not have lasting influence on growth of teak or on soil properties, a modification in the current practice is suggested. All wood down to 10 cm girth over bark - the lower limit upto which firewood collection may be commercially viable - could be salvaged and marketed. The balance may either be burned (resulting in a light slash burning) or left at site (to deteriorate over time) depending on local conditions.

6. LITERATURE CITED

Alexander T. G., Sobhana K.. Balagopalan M. and Mary M.V. 1980. Taungya in relation to soil properties, soil erosion and soil management. Kerala Forest Research Institute Res. Rep. No.4, 24p.

*Coster I. C. 1932. Burning on areas to be planted with teak. Tectona XXV(2).

Evans J. 1982. Plantation forestry in the tropics. Clarendon Press, Oxford, 472p.

Gomez K. A. and Gomez A. A. 1984. Statistical procedures for agricultural research, John Wiley and Sons, New York. 680p.

*Griffith A. L. 1937-38. Annual report on silvicultural research in the Madras Presidency.

Griffith A. L. 1946. The effects of burning on the soil as a preliminary to artificial regeneration. Indian Forest Bull. No. 130. Dehra Dun, 34p.

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*from Griffith A. L.1946.

Jackson M. L. 1973. Soil Chemical Analysis. Printice Hall of India, New Delhi. 498 p.

Kraemer J. F. and Herman R. K. 1979. Broadcast burning. 25 year effects on forest soils in the western flanks of the Cascade mountains. Forest Sci , 25:427 -439.

Mroz C.D., Jurgensen M.F., Harvey A. E., and Larsen M J. 1980. Effects of fire on nitrogen in forest floor horizons. Soil Sci. Soc. Am. J. 44: 395-400.

Nye P. H. and Greenland D. J 1960. The soil under shifting cultivation. Commonwealth Bureau of Soils. Techn. Comm. 51. CAB Farnham Royal. 156p.

Nye P. H. and Greenland D. J.1964. Changes in soil after clearing a tropical forest. Plant and Soil 21: 101-112.

Rashid G. H. 1987. Effects of fire on soil carbon and nitrogen in a Meditteranean oak forest of Algeria. Plant and Soil 103: 83-93.

Sudheendrakumar V. V. and Chacko K. *C*. 1986. Effect of site preparation on incidence of termites in *Eucalyptus* plantations. In: Eucalypts in India: Past, Present and Future, (eds. J. K. Sharma, C. T S. Nair, **S.** Kedharnath and S.Kondas), 364-366, Kerala Forest Research Institute, Peechi.

APPENDIX I

Cost of raising one hectare of teak plantation in Karulai Range of Nilambur Division during 1981.

Sl. No.	Operation	Amount (in rupees)
1	Slash felling	370.50
2	i. First burning	18.51
	ii. Heaping and burning	444.59
3	i. Cost of bamboo stakes (60 cm long)	74.13
	ii. Transport of bamboo stakes to planting site	18.53
4	Alignment and staking	139.05
5	Cost of crowbar planting	92.66
6	Surveying and fixing boundary	176.00
	Total	1333.97

Source : Forest department records, Karulai Range.