Indian Journal of Natural Rubber Research, 8(1) : 13-20,1995

POLYTHENE MULCHING IN RUBBER SEEDLING NURSERY

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Lakshmanan, R., Punnoose, K.I., Mathew, M., Mani, J. and Pothen, J. (1995). Polythene mulching in rubber seedling nursery. *Indian Journal of Natural Rubber Research*, 8 (1) : 13-20.

The feasibility of using polythene films as mulch in rubber seedling nursery was investigated. Field studies were conducted with three types of clear polythene films, conventional plant mulch and an unmulched control. The polythene mulches were topped with a thin layer of soil of over 5 cm thickness . Mulching significantly enhanced seedling growth. Polythene-mulched plots recorded 15.5 to 28.9 per cent increase in plant diameter over the unmulched plots and compared favourably with plant mulch. The soil moisture content in the surface 0-15 cm soil layer with polythene mulching was 87-113 per cent more than that in the unmulched plots during extreme dry weather conditions, while the increase with plant mulching was only 50 per cent. The extent of weed control achieved with polythene mulching was 84 to 90 per cent and that with plant mulching 56.9 per cent, over the unmulched plots. Mulching with polythene sheets did not increase absolute soil temperature over the conventional plant mulches. Soil temperature fluctuations were also minimised due to mulching.

Key words : Rubber nursery, Mulching, Polythene film, Plant mulch, Soil temperature, Weed control.

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INTRODUCTION

Surface mulching influences soil temperature and minimises evaporative losses thereby modifying soil microclimatic conditions for plant growth. Modification of soil thermal regime in turn influences root development, soil microbial activity and nutrient bioavailability (Aino, 1981; Duncan *et al.*, 1992). Mulching also helps to control weeds and aids in soil and water conservation.

Recent concern about availability of conventional materials for mulching has necessitated search for alternative materials. The possibility of using plastic films for mulching has been reported by several workers (Waggoner *et al.*, 1960; Maurya and Lal, 1981 and Duncan *et al.*, 1992). Hanada (1991) studied the effect of using black, green and transparent plastic films as mulch in temperate subtropical and tropical regions and concluded that plastic mulching in hot climates caused marked increase in soil temperature thereby adversely affecting plant growth.

Coloured polythene mulch films were reported to increase soil temperature by 5-7°C facilitating faster germination and better root proliferation whilst checking weed growth, preserving soil structure, retaining soil moisture and increasing the carbon-dioxide content around the plant (Gutal *et al.*, 1992). Stapleton *et al.* (1989) observed around 82 per cent reduction in ground coverage by weeds as a result of polythene mulching. Studies on polythene mulching generally involves spreading of the polythene films and anchoring them with pegs. In the present investigation an attempt has been made to study the possibility of using polythene films topped with a thin layer of soil as a mulch material and to evaluate its cost effectiveness over the conventional plant mulches normally used in rubber seedling nursery.

MATERIALS AND METHODS

The study was conducted at Central Nursery, Karikkattoor, Kerala (Lat. 9° 22' N, Long. 76° 50' E, Altitude 100 m MSL). The experiment was laid out in randomised block design with five treatments replicated four times. The treatments included four different types of mulch materials viz., clear polythene sheets of 40 and 100 gauge, used rainguard polythene sheets of 250 gauge, conventional plant mulch (broad leaf mulches of 5 cm thickness) and an unmulched control. Sufficient number of holes were punched in the polythene sheets after which the sheets were laid out in strips in the inter-row area and a thin layer of soil of 0.5 cm thickness placed above the sheets to prevent drifting away by wind. Mulching was undertaken during the month of November by which time the seedlings were around four months old and fertilizer application completed as per the recommended package. All the treatments were sprinkler irrigated uniformly once a week. Soil thermometers were installed in the field at 5 cm, 10 cm and 20 cm soil depths in all the treatments. Soil temperature was recorded daily at 0800 IST and 1430 IST.

Weed flora coverage was evaluated 45 days after mulching. Visual scoring was done on a subjective scale of 0-100 per cent, where 0 represents a completely weed free area and 100, an area completely covered by weed growth. Five plants were destructively sampled at one and six months after mulching to study the plant biomass and rooting characteristics. Soil moisture was estimated from samples collected at 0-15 cm and 15-30 cm depths. The meteorological data were collected from the nearby Central Experimental Station of the Rubber Research Institute of India (Table 1).

RESULTS AND DISCUSSION

Growth characteristics and leaf nutrient status

Mulching showed no significant influence on diameter and height of the plants for a period upto two months (Table 2).

Table 1. **Weather data at the Central Experiment Station, Chethackal**

Month	Mean rainfall (mm)	Temperature (°C) Maximum	Temperature (°C) Minimum	Mean evaporation (mm)	Number of rainy days
1988					
October	5.73	32.2	22.4	3.43	10
November	8.18	31.6	21.8	3.12	9
December	1.93	32.1	20.1	3.80	3
1989					
January	0.62	33.6	19.7	4.4	
February	0.14	35.3	18.6	4.8	
March	3.45	35.7	21.1	5.1	9
April	9.10	34.0	23.3	4.7	14
May	6.88	32.1	23.5	4.4	15

Table 2. **Growth attributes of rubber seedlings as influenced by mulching**

Treatment	Pretreatment		Period						Number of whorls	Total number of leaves	Total leaf area/ plant (cm^2)	Plant biomass (g) months after mulching	
	Diameter (cm)	Height (cm)	2		4		6					1	6
			D	H	D	H	D	H					
Polythene sheet													
40 gauge	0.41	41.9	0.65	67.6	1.12	109.8	1.33	153.3	3.7	21.47	4156.2	29.25	207.5
100 gauge	0.40	42.5	0.65	71.0	1.19	105.5	1.36	156.1	3.6	20.29	4913.9	28.96	173.6
250 gauge	0.43	42.9	0.67	69.3	1.25	118.1	1.41	172.7	3.8	23.29	5677.1	32.72	174.9
Plant mulch	0.41	43.6	0.64	66.5	1.18	111.5	1.36	160.7	3.6	21.15	5061.1	34.00	200.1
No mulch	0.42	45.0	0.57	63.1	0.97	89.5	1.11	132.6	3.5	17.57	3128.7	28.69	106.1
SE ±	0.014	1.74	0.02	3.18	0.03	4.17	0.04	4.55	0.12	0.86	651.0	2.58	20.16
CD (P=0.05)	NS	NS	NS	NS	0.09	12.86	0.12	14.01	NS	2.65	NS	NS	65.74

D : diameter (cm) H : height (cm)

Table 3. **Rooting characteristics of rubber seedlings**

Treatment	Root dry weight (g)	No. of surface roots (collar region)	Length of taproot (cm)	Mean lateral extension of surface roots (cm)
Polythene sheet				
40 gauge	41.44	15.33	53.0	28.74
100 gauge	33.28	17.66	59.9	30.63
250 gauge	38.01	14.92	50.1	31.63
Plant mulch	42.05	12.91	59.5	24.37
No mulch	21.08	8.99	62.4	19.06
SE ±	2.49	1.38	6.63	3.52
CD (P = 0.05)	5.73	4.25	NS	NS

However, from the fourth month after mulching significant differences in growth of the seedlings were observed between the mulched and the unmulched plots. The same trend was reflected at six months after mulching. The absence of any significant difference among the mulched treatments shows that polythene mulch compares favourably with plant mulch and does not cause any adverse effect on growth of rubber. The polythene mulched plots recorded 15.5 per cent to 28.9 per cent increase in plant diameter over the unmulched plots by the fourth month after mulching, the increase by the sixth month being 19.8 to 27 per cent. Plant height increased by 17 to 31.8 per cent and 15.6 to 30.2 per cent over that of the control by the fourth and sixth month respectively after mulching. No significant difference was observed with respect to the number of whorls between the different treatments while the number of leaves was significantly higher for the mulched plots. The unmulched plots also recorded a significantly lower plant biomass and a lower value of leaf area than the mulched plots (Table 2). Better growth of rubber seedlings under South Indian conditions with one round of plant mulching by the onset of summer has been reported by Potty *et al.* (1968).

Root weight (on dry weight basis) and the number of surface roots at the collar region were significantly higher in the mulched plots over that of the unmulched plots. The maximum depth of tap root penetration and the maximum lateral extension of surface roots though less in the control plots was not significantly different from the mulched plots (Table 3).

There was no significant difference in N, P, K, Ca and Mg content of the leaves due to the effect of mulching (Table 4).

Soil moisture

As irrigation was given uniformly to all the plots once in a week no severe moisture deficit was noticed in any of the treatments (Table 5). However, during February (three months after mulching) in general, lower values of soil moisture were observed for all the treatments. This can be attributed to the very low quantity of rainfall received and the least number of rainy days coupled with the higher evaporative demand of the atmosphere (Table 1) . Hence even with irrigation, being given uniformly to all the treatments, significant difference in soil moisture content was observed during the month of February. Soil moisture at 0-15 cm depth was significantly higher in the 100 and 250

Table 4. **Leaf nutrient status as influenced by mulching**

Treatments	Nutrient concentration (5%)				
	N	P	K	Ca	Mg
Polythene sheets					
40 gauge	3.42	0.27	1.02	0.75	0.26
100 gauge	3.04	0.25	1.03	0.68	0.27
250 gauge	3.44	0.26	1.13	0.78	0.21
Plant mulch	3.31	0.26	0.98	0.74	0.31
No mulch	3.23	0.25	1.02	0.71	0.22
SE ±	0.14	0.014	0.07	0.04	0.03
CD(P=0.05)	NS	NS	NS	NS	NS

gauge polythene mulched plots followed by the 40 gauge polythene mulched and the plant mulched plots. The least value of moisture content in the surface 0-15 cm depth was observed in the unmulched plots. The polythene mulched plots recorded an average of 87 to 113 per cent more soil moisture in the surface 0-15 cm soil layer than that in the unmulched plots while the increase in soil moisture content with conventional plant mulching was only 50 per cent. The moisture content in the 15-30 cm soil layer during the same period was significantly lower in the unmulched plot while all the mulch treatments showed similar values of moisture content.

Weed growth

Mulching with polythene sheets brought about a significant reduction in overall weed growth (Table 6) the extent being dependent on the thickness of the polythene sheets. Use of conventional plant mulches and polythene mulches reduced weed growth to the extent of 56.9 per cent and 84 to 90 per cent respectively over the unmulched control irrespective of the type of weed.

Table 5. **Soil moisture content**

Treatment	Soil moisture (%)							
	0-15cm				15-30 cm			
	Jan.	Feb.	Mar.	Apr.	Jan.	Feb.	Mar.	Apr.
Polythene sheets								
40 gauge	21.2	16.1	23.2	29.6	21.2	15.9	24.4	29.5
100 gauge	22.3	18.1	25.1	29.1	21.4	16.5	23.8	29.1
250 gauge	22.4	18.3	24.9	31.0	21.3	17.5	24.2	30.2
Plant mulch	20.3	12.9	24.5	30.6	23.6	16.8	26.3	30.0
No mulch	22.0	8.6	23.9	28.5	18.8	12.9	24.5	29.5
SE ±	1.53	1.43	1.04	0.82	1.91	0.73	0.93	0.87
CD (P=0.05)	NS	4.4	NS	NS	NS	2.30	NS	NS

Table 6. **Weed canopy coverage (angular transformed value) 45 days after treatment imposition**

Treatment	Overall weed canopy coverage		Broad leaf coverage		Narrow leaf coverage	
Polythene sheets						
40 gauge	19.52	(11.30)	7.54	(2.00)	17.70	(9.25)
100 gauge	17.05	(8.80)	5.74	(1.00)	15.98	(7.75)
250 gauge	15.68	(7.50)	5.74	(1.00)	14.50	(6.50)
Plant mulch	33.33	(31.25)	22.50	(15.00)	22.25	(16.25)
No mulch	58.61	(72.50)	20.47	(12.50)	50.89	(60.00)
SE ±	3.42		1.65		3.31	
CD (P=0.05)	10.54		5.09		10.21	

Figures in paranthesis indicate values in per cent

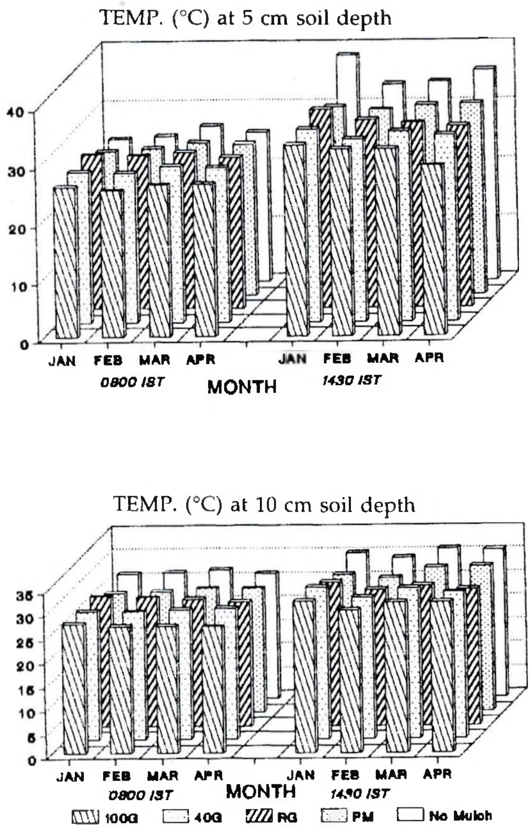

Fig. 1. Soil temperature at 5 and 10 cm depths with different mulch materials

Soil temperature

Soil temperature recorded at 0800 IST did not show much variation between the mulched (polythene/plant mulch) and unmulched control plots at 5 cm and 10 cm soil depths (Figure 1). However, at 1430 IST, the unmulched plots recorded higher values of soil temperature at both the soil depths compared to the mulched plots. The mulched plots, irrespective of the type of mulch used, showed only negligible differences in soil temperature. Mulching the soil surface helps in reducing the sudden variations in surface soil temperature. The effect of a mulch on soil temperature depends largely on its type, the amount applied and its rate of decay (Othieno, 1982).

The difference in soil temperature recorded at 0800 IST and 1430 IST was computed to study the temperature fluctuations (Figure 2). Soil temperature fluctuation at 5 cm soil depth was to the tune of 7.4 to 14.1°C in the unmulched control plots.

The mulched plots irrespective of the type of mulch used, maintained more or less the same surface soil temperature, the extent of variation being in the range of 5 to 7.4°C. Mulching or frequent surface wetting

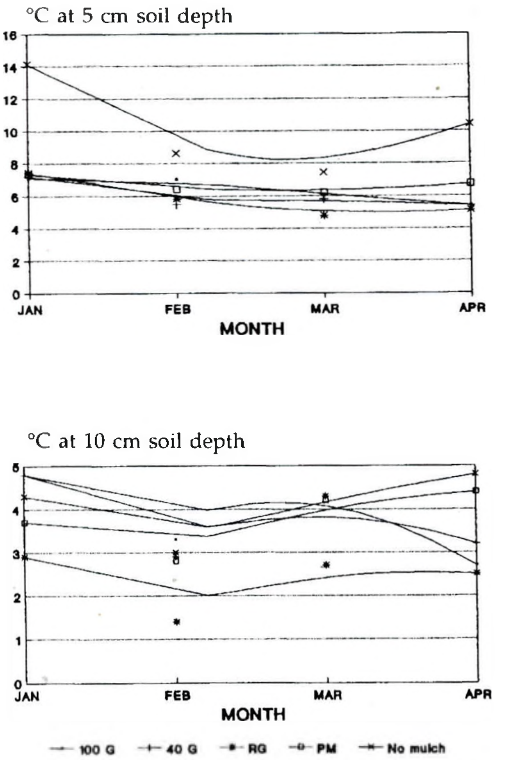

Fig. 2. Effect of mulching on day-time soil temperature fluctuation

changes the thermal capacity of the surface layer to avoid extreme heating or cooling (Kakde, 1985). At 10 cm soil depth the range of soil temperature fluctuation was, in general less than that at 5 cm depth for all the treatments. At this depth, plots mulched with rainguard polythene showed the least variation in soil temperature fluctuation (1 to 2.7 °C) . Both shading by the canopy and application of mulches influece diurnal fluctuations in soil temperature (Othieno and Ahn, 1980). No marked fluctuation in soil temperature at 20 cm soil depth was observed between the mulched and unmulched plots (Table 7) .

The placement of a layer of soil of 0.5 cm thickness over the plastic mulch and the presence of a canopy coverage of 30 to 40 per cent prevented the direct heating of the polythene sheets. Hence an increase in soil temperature with plastic film mulching as reported by other workers (Maurya and Lal, 1981; Sui Hong-Jian *et al.,* 1992) was not observed in the present study . Placement of a layer of soil over the plastic film also prevents drifting away of the plastic by wind besides preventing loss of soil moisture through the punched holes.

Cost analysis

A comparative cost analysis of the different mulch materials (Table 8) showed that polythene mulching was less costly compared to plant mulching. Used rainguard polythene sheets (250 gauge) showed a cost saving of 44.6 per cent over that of plant mulches. Though the percentage saving was less with the 250 gauge used rainguard polythene, the material can be reused for 2-3 seasons compared to that of

Table 7. **Soil temperature variation at 20 cm soil depth**

Treatments	Soil temperature (°C)							
	January		February		March		April	
	0800	1430	0800	1430	0800	1430	0800	1430
Polythene sheets								
40 gauge	29.5	29.5	29.3	27.6	27.9	28.8	28.3	28.9
100 gauge	29.1	29.5	28.8	27.5	28.0	28.5	26.5	27.8
250 gauge	29.3	29.3	29.1	28.1	28.3	28.5	26.9	28.1
Plant mulch	27.8	28.1	28.2	27.0	27.7	28.3	27.6	28.1
No mulch	28.7	28.9	29.4	27.7	28.5	29.3	27.8	28.1

Table 8. **Economics of mulching with polythene/plant mulches**

Treatment	Quantity (kg/ha)	Cost of material per ha (Rs)	Labour cost for spreading mulches (Rs)	Total cost (Rs)	% Saving
Polythene sheets					
40 gauge	51	2200	1200	3400	74.8
100 gauge	128	5280	1200	6480	52.1
250 gauge	500	5500	2000	7500	44.6
Plant mulch	625 bundles of 35 kg each	10937	2600	13537	—

Labour task for polythene mulching : 2.025 ares/worker/day.
Labour task for plant mulching : 35 kg leaf mulch/worker/day.

the 40 and 100 gauge sheets. The labour cost involved in spreading out the used rainguard polythene was higher since the small strips had to be first spread out, touching each other before placing a layer of soil over the sheets.

CONCLUSIONS

Polythene sheets can be used as an alternative to plant mulches without any adverse effect on plant growth. As the used rainguard polythene sheets can be reused 2-3 seasons, the total cost of mulching with used rainguard polythene sheets will work out to be much lower than that with plant mulching. The only drawback observed with the use of polythene mulches is the absence of any nutrient addition which is otherwise obtained through mulching with plant materials.

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