TEAK (*TECTONA GRANDIS*) GROWTH IN RESPONSE TO WEED CONTROL TREATMENTS

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ANOOP, E.V., KUMAR, B. MOHAN & ABRAHAM, C.T. 1994. Teak (*Tectona grandis*) growth in response to weed control treatments. A field experiment was conducted to test the efficacy of seven weed control treatments in teak (*Tectona grandis*) in the peninsular Indian state of Kerala. Glyphosate, paraquat, 2,4-D+ dalapon, manual weeding, ring weeding (paraquat) and ring weeding (manual) treatments were applied twice at one-year interval in a fourteen-month-old stand. Growth measurements were recorded at 5 months, 19 months and 22 months after the first application. Manual weeding produced rapid height growth at twenty two months after weeding. It was, however, statistically at par with paraquat and glyphosate applications. Paraquat at the rate of 0.8 $l\ ha^{-1}$ registered the highest radial growth, and was also cheaper.

Keywords: Weed control - teak - India - glyphosate - paraquat - 2,4-D + dalapon - manual weeding - ring weeding

ANOOP, E.V., KUMAR, B.MOHAN & ABRAHAM, C.T. 1994. Tindakbalas tumbesaran jati (*Tectona grandis*) terhadap rawatan kawalan rumpai. Satu percubaan tapak dijalankan untuk menguji keberkesanan tujuh rawatan kawalan rumpai dalam jati (*Tectona grandis*) di negeri Kerala, di kawasan semenanjung India. Glifosfat, parakuat, 2,4 -D + dalapon, 'manual weeding', 'ring weeding' (parakuat) dan 'ring weeding (manual)' digunakan dua kali dalam selang masa satu tahun, pada satu dirian jati yang berumur 14 bulan. Ukuran tumbesaran direkodkan pada 5 bulan, 10 bulan dan 22 bulan selepas aplikasi pertama. Dua puluh dua bulan selepas merumpai, didapati bahawa 'manual weeding' menghasilkan ketinggian yang meningkat dengan cepat. Bagaimanapun, nilai statistik yang dihasilkan oleh 'manual weeding' ini sama dengan nilai dari aplikasi parakuat dan glifosfat. Parakuat pada kadar 0.8 $l\ ha^{-1}$ mencatatkan pertumbuhan jejari yang tertinggi dan murah juga.

Introduction

Teak, one of the most versatile timber species of the Orient, is grown extensively in plantations throughout India. Incidentally, the world's first teak plantation was established at Nilambur, Kerala in peninsular India, about 150 years ago. The total area under teak plantations in the country has been estimated

to be 7,125,000 *ha* (CFC 1984). The productivity of most of these plantations is, however, very low (6.5 m^3 ha^{-1} y^{-1}, Agarwal 1985). Excessive weed growth is a major problem in teak growing areas, especially in young plantations, since teak is shade intolerant (Troup 1921) and seedlings are very sensitive to weed suppression.

Hand weeding is the most common traditional method of weed control adopted in these teak plantations, but repeated manual weeding, though desirable, is labour intensive. With labour becoming more and more scarce and costly, herbicides may offer an attractive option. Available literature, although limited, does indicate the suitability of herbicidal control of weeds in teak plantations; paraquat apparently is suitable to control *Chromolena odorata* and dalapon has been suggested for controlling perennial grasses like *Vetiveria zizaniodes* and *Demostachya pinnata* (Nair 1973). However, the weed complex is a mixture of many different species and rarely does any one herbicide control all competitors. Hence, a variety of herbicides are often required for effective control of weeds in forestry situations. Nevertheless, detailed studies are yet to be undertaken to develop herbicide recommendations for controlling weeds in teak plantations. Therefore, the present investigation was taken up with the objective of comparing the efficacy of manual method of weed control during the establishment phase of teak *vis-a-vis* three selected herbicide formulations and two ring weeding treatments and developing a weed control recommendation for young teak plantations.

Methodology

The study area was located in the Kalindi block of the Kerala Agricultural University estate at Vellanikkara (10°32'N latitude, 76°16'E longitude; 22.25 *m* above sea level), Trichur, Kerala (Figure 1). The soil of the experimental site was of lateritic origin with a pH of 5.45. (soil organic matter content 2.04%, nitrogen content 0.13%, available P 0.0084% and available K 0.0015%). The site was previously under rubber (*Hevea brasiliensis*) which was clear-felled during 1985-86. One-year-old containerized teak seedlings were planted at 2×2 *m* spacing after clearing and burning approximately 1.0 *ha* area during June, 1988. Survival of the planted seedling was rated as very good (96%).

The weed spectrum comprised both grasses and broad-leaved species. Some of the predominant broad-leaved species included: *Chromolena odorata, Mimosa pudica, Pueraria phaseoloides, Stachytarpheta indica, Ipomea obscura* and *Hemidesmus indicus.* Grasses were : *Pennisetm pedicellatum* and *Centrosema pubescens.* Shrubs and trees consisted of *Bridelia retusa, Bombax malabaricum, Ficus hispida* and *Zizyphys oenoplia.*

The plantation was subdivided into twenty-eight 6×10 *m* plots (using wooden pegs) with a minimum number of 12 trees per plot and the following weed control treatments were superimposed in a randomized block design having four replications.

T1 - Glyphosate (0.8 *kg ha*$^{-1}$; Weedoff, 41% SL; NOCIL)
T2 - 2, 4-D (0.2 *kg ha*$^{-1}$; agrodone, 34% EC; AGROMORE) + dalapon (0.8 *kg ha*$^{-1}$; dalapon sodium salt, 74% WSP; DOW)
T3 - Paraquat (0.8 *kg ha*$^{-1}$; gramaxone, 20% WSC; ICI, India)
T4 - Ring weeding (paraquat): 1 *m* radius around the saplings was sprayed with paraquat (0.8 *kg ha*$^{-1}$)
T5 - Ring weeding (manual): weeds in 1 *m* radius around the saplings were cut and the debris removed
T6- Manual weeding: weeds were cut at the ground level and the debris spread uniformly all over the plots
T7- Weedy check (control)

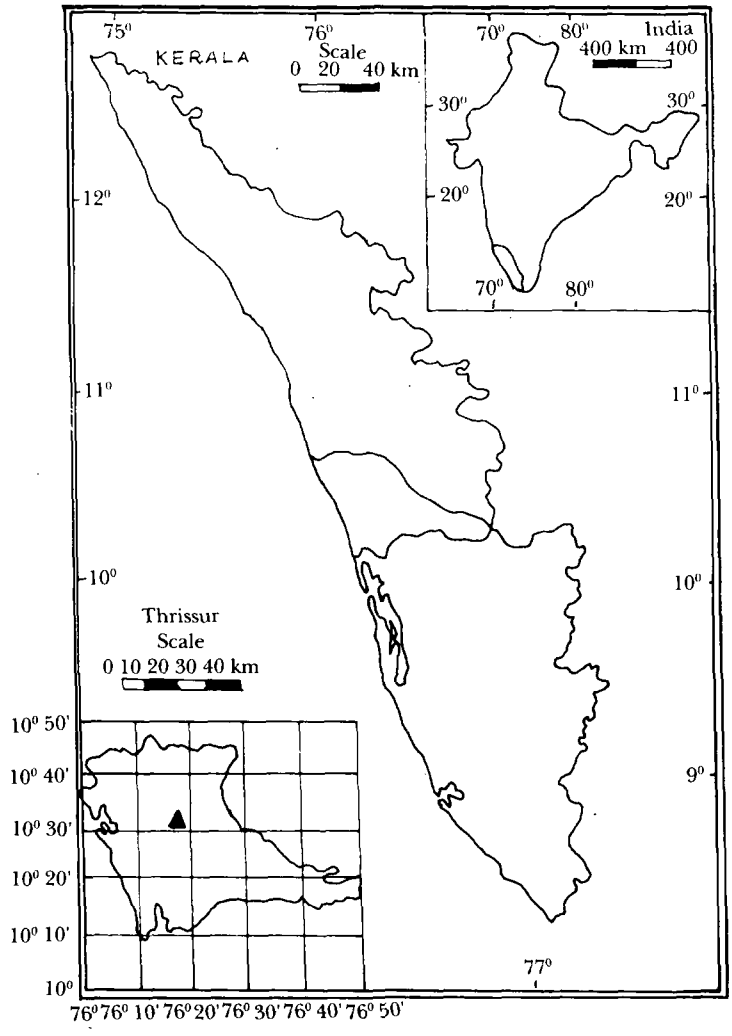


Figure 1. Map of Kerala showing the location of the study area (experimental site)

All the herbicides were applied at the prescribed rates when the stand age was 14 months using a Knap sack sprayer at the rate of 500*l* of spray fluid per *ha.* A repeat application was made after one year, *i.e.*, when the stand age was 26 months.

Height and basal stem diameter measurements of all saplings were recorded at 5 months, 10 months and 22 months after first application. Since 2, 4-D caused severe damage to teak saplings during the first few months, the data were analyzed after excluding T2 (2, 4-D + dalapon) from the data-set, following the analysis of variance.

Results and discussion

The weed control treatments significantly influenced mean height ($p < 0.01$, $F = 10.51$) and basal stem diameter ($p < 0.01$, $F = 16.52$) (Table 1) of teak saplings at the final stage of observation (22 months after the first application of herbicides; Figures 2 and 3). Manual weeding registered the highest mean height (4.5 *m*) and was markedly superior (LSD = 0.72) to weedy check (39% higher) and the two types of ring weeding treatments at this stage. However, it was statistically at par with glyphosate and paraquat.

In radial growth, paraquat recorded the highest basal stem diameter of 7.84 *cm* at 22 months, followed by manual weeding (7.58 *cm*) and glyphosate (7.37 *cm*). They were significantly superior ($p < 0.01$, LSD = 0.98) to both ring weeding treatments and weedy check. Paraquat and glyphosate were, however, statistically equivalent to manual weeding.

Manually weeded plots recorded the highest mean diameter of 4.4 *cm* followed by paraquat (3.65 *cm*) at 10 months after treatments (significant at 5% level). Other treatments occurred in the order : manual ring weeding (3.52 *cm*), weedy check (2.94 *cm*), glyphosate (2.82 *cm*) and paraquat ring weeding (2.78 *cm*). Height differences were not significant at the ten- month and five-month stages, although paraquat registered the highest mean value which was 35.5% higher than the control at the 10- month stage.

Table 1. Summary of analysis of variance

Source	D.F.	Mean Squares					
		Height			Basal stem diameter		
		5 *mth*	19 *mth*	22 *mth*	5 *mth*	19 *mth*	22 *mth*
Treatments	5	0.113	0.165	2.428**	0.359	1.589*	6.956**
Replication	3	0.046	0.028	0.372	0.260	0.979	0.631
Error	15	0.110	0.132	0.231	0.255	0.444	0.421
Total	23						

mth : months after first application
* : Significant at 5 % level
** : Significant at 1 % level.

Teak saplings are generally very sensitive to weed suppression (Troup 1921). Bryant (1968) also noted that survival and growth rate of young teak were better in weeded areas than in unweeded or partially weeded plantations. The present results confirm the necessity for timely weed control in teak plantations.

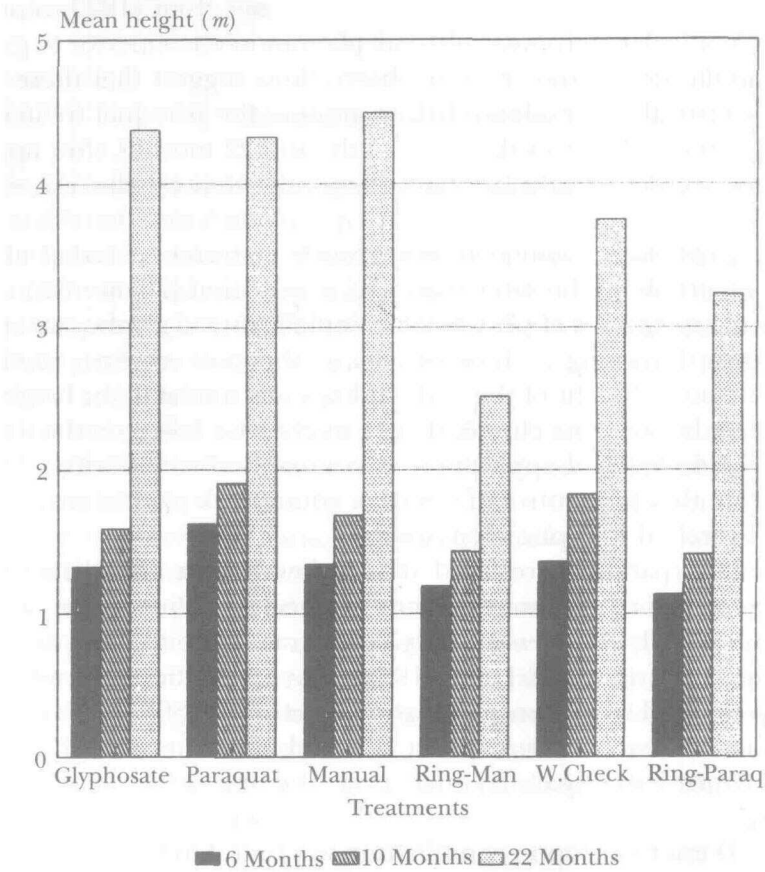
On the whole, manual weeding, paraquat and glyphosate were superior methods of weed control for young stands of teak. The timely control of weeds and the concomitant reduction in the magnitude of inter-specific competition might have ultimately resulted in the better growth of teak saplings. Nair (1973) reported that manual weed control in a five-year-old teak plantation was superior to gramaxone (paraquat) application. However, our observations suggest that these two treatments were statistically equivalent. In fact, trees in the paraquat treated plots recorded the highest radial growth (at 5 months and 22 months after application) and the highest seedling height (at 5 and 10 months after application, see Figures 2 and 3).

Similarly, glyphosate stimulated teak growth in terms of radial and height increments especially in the later stages of observation (22 months). However, we noticed mild symptoms of phytotoxicity initially due to glyphosate application (localized foliar browning). Incidentally, at the time of first application of herbicides, the mean height of the teak saplings was similar to the height of weeds (ca. 1.2 *m*) and hence some chemical drift might have fallen on the teak foliage, despite directed chemical application to control herbicidal drifts. Hence, the results indicate that for control of weeds in young teak plantations, utmost care needs to be exercised if glyphosate is used.

Ring weeding (paraquat) resulted in very low height and diameter growth on all three occasions. Although weeds in the 1*m* radius circle around the saplings were initially suppressed, they regenerated rapidly. As paraquat is not a persistent herbicide (Gupta & Lamba 1978), spot application around the saplings did not help in weed suppression. Maghembe *et al.* (1986) also found that spot weeded plots of *Leucaena leucocephala* showed minimum growth compared to other weed control strategies. Manual ring weeding was better than paraquat ring weeding.

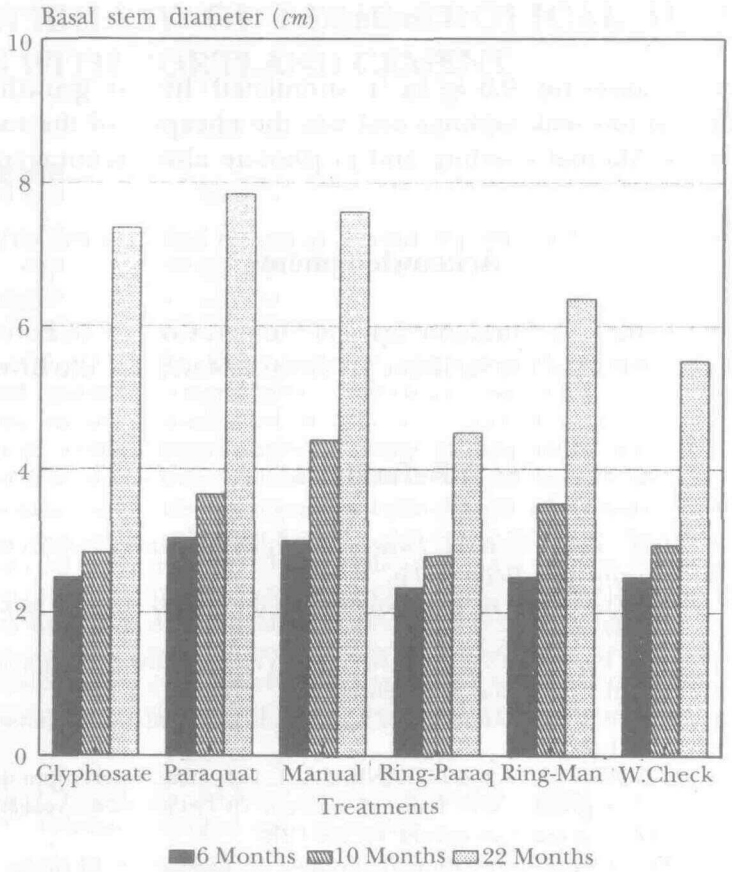
The 2, 4 - D ester + dalapon combination was found to have a very deleterious effect on teak saplings. Although maximum care was taken while applying the herbicide, drying of terminal buds followed by death of teak saplings was noticed in the third month after the herbicide spray. The high teak mortality rate (88% could be attributed to the toxic effect of 2,4-D ester in the herbicide mixture. While dalapon is a general grass killer, 2,4-D is typically a dicot killer and in some cases it is also used as a tree killer (Gupta & Lamba 1978). Hence 2,4-D ester at the rate of 0.8 $kg\ ha^{-1}$ either in mixtures or alone cannot be recommended for herbicidal control of weeds in young teak plantations. However, such phytotoxic effects were not observed by Soni (1980) in the case of weed control in two-year-old pine plantations where a mixture of 2, 4-D and 2,4.5-T was used. This again points out the species-specific phytotoxic effects of 2, 4-D.

The economic analysis (Table 2) indicates that among the weed control treatments tried, paraquat forms the most cost-effective option. On a per hectare basis, paraquat (at 0.8 *kg* ha^{-1}) would cost only Rs 632/- (US$ 49) at 1989 rates, including the labour charges for a single application, whereas the expenses for manual weeding of a 1-*ha* plantation using women labourers would be around Rs 1750/- (US$ 135).



Ring-Paraq. = ring weeding-paraquat, Ring-Man. = ring-weeding-manual, W.Check = weedy check

Figure 2. Mean height of one-year-old teak saplings at different periods after weed control treatments



Ring-Paraq. = ring weeding-paraquat, Ring-Man. = ring-weeding-manual, W.Check = weedy check

Figure 3. Mean basal stem diameter of one-year-old teak saplings at different periods after the weed control treatrents

Table 2. Economic analysis of the weed control treatnents on per hectare basis at 1989 rates

Treatment	Cost of chemicals (Rs)	Cost of application (Rs)	Total (Rs)
Glyphosate (Weed Off)	751	35	786
2,4-D (agrodon conc.) + dalapon	169	35	204
Paraquat (gramaxone)	532	35	567
Manual weeding	-	1,750	1,750
Ring weeding (manual)	-	3,500	3,500
Ring weeding (paraquat)	532	35	567

Conclusion

Paraquat application (at 0.8 *kg ha*$^{-1}$) stimulated height growth and radial growth of one-year-old teak saplings and was the cheapest of the weed control treatments tested. Manual weeding and glyphosate also encouraged early teak growth.

Acknowledgments

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