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# EFFECT OF VARYING SOIL MOISTURE AND BULK DENSITY OF TEAK , EUCALYPT AND ALBIZIA ROOT GROWTH

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# INTRODUCTION

Root studies had been neglected in the past compared to shoot mainly due to two reasons - firstly, since they seemed to fulfil only the secondary functions of absorbing water and nutrients and anchoring the plant, and secondly, due to their concealment in the soil. The stresses which roots experience in soil fall into three broad interrelated groups - physicial stresses due to inadequate moisture and air, unfavourable temperature or mechanical impedance, chemical stresses resulting from nutrients and toxic substances, and biological stresses caused by the soil organisms.

Compaction of soil results in the destruction of the larger pores, partially filling them with solid particles. The size of the soil pores is of importance in the penetration of roots. Roots are unable to enter pores narrower than their root caps (Wiersum, 1957; Cannell, 1977). Thus if they are to grow through compact soil, they must displace soil particles to widen the pores by exerting a pressure greater than the soil's mechanical strength. Soil compaction also impedes the movement of water and air by reducing the number of large pores thus exposing the roots to several simultaneous stresses.

Surface mineral horizons of forest soils are sensitive to compaction because of characteristically high total porosities and low internal shear strengths (Lenhard, 1986). Root and shoot growth of various tree species have been reported to decrease with increasing bulk density (Squire et al., 1978; Froehlich, 1979; Monti & Mackintosh, 1979; Heilman, 1981; Davis, 1984; Wasterlund, 1985) though degree of tolerance or adaptability varies from species to species. This study was an attempt to understand the effect of soil compaction and associated decrease in soil moisture content on root growth of teak, eucalypt and albizia.

# MATERIALS AND METHODS

Surface soil (0-20 cm) from the Peechi campus was used. It is a dark brown, granular, sandy loam derived from granitic gneiss parent material. The soil has a water holding capacity of 32%. organic carbon 1.7%, pH 5.9, exchange acidity 3 m. e. %, and exchangeable bases 9 m.e. %.

Trials were conducted initially on bare root seedlings of eucalypt and albizia in PVC pots (15 cm ht., 7 cm inner dia.) with soil adjusted to bulk densities 1.2, 1.5 and 1.7 $gcm^{-3}$ . It was discontinued after three months since the experiment was intended as a preliminary trial only. Further trials were conducted in concrete pots (35 cm ht., 25 cm inner dia.) the results of which alone is discussed here. The results of the preliminary trial are included in a detailed report.

Soil was compacted to three different bulk densities: i. 1.1 g $cm^{-3}$ ii. 1.4 g $cm^{-3}$ and iii. 1.6 g $cm^{-3}$. The corresponding maximum water holding capacities were 27, 16, and 14 percent respectively. Nine replications were provided for each treatment with one plant in each replicate. Six week old seedlings of Teak *(Tectona grandis),* Eucalypt *(Eucalyptus tereticornis)* and Albizia *(Paraserianthes falcataria)* raised in polypots were transplanted in the concrete pots. Harvesting was done after six months and measurements taken.

Root length and shoot length as well as their biomass, number of leaves and internodal length were measured. Root length refers to the length of the longest root. In the case of teak, the stump portion was not included in root biomass estimation and in albizia the leaflets were not taken into consideration while counting the number of leaves.

Statistical analyses were carried out using Analysis of Variance and Duncan’s New Multiple Range Test (Keppel, 1973).

# RESULTS

Bulk density (BD) and associated soil moisture was found to influence the growth of teak, eucalypt and albizia. The results presented in Figs. 1-6 are discussed below.

## Teak

The second and third treatments ($t_2$ & $t_3$) significantly reduced the root length of teak **(35%)** as compared to $t_1$ while the reduction by $t_3$ in relation to $t_2$ (13%) was not remarkable. Shoot length increased first **(37%)** with $t_2$ compared to $t_1$ and then decreased 37% by $t_3$ in relation to $t_2$ Root biomass production was severely hampered by soil compaction and moisture stress. It was brought down 41% by $t_3$ and further 73% by $t_3$ as compared to $t_1$ and $t_2$ respectively. The first and second treatments did not differ in shoot biomass production though $t_3$ reduced it 45% as compared to $t_2$ The treatments did not produce any appreciable effect on leaf production. Number of leaves increased 17% by $t_2$ in relation to $t_1$ and then descreased 7% by $t_3$ when compared with $t_2$. Internodal length increased 25% by $t_2$ with respect to $t_1$ and then decreased 48% by $t_3$ compared to $t_2$.

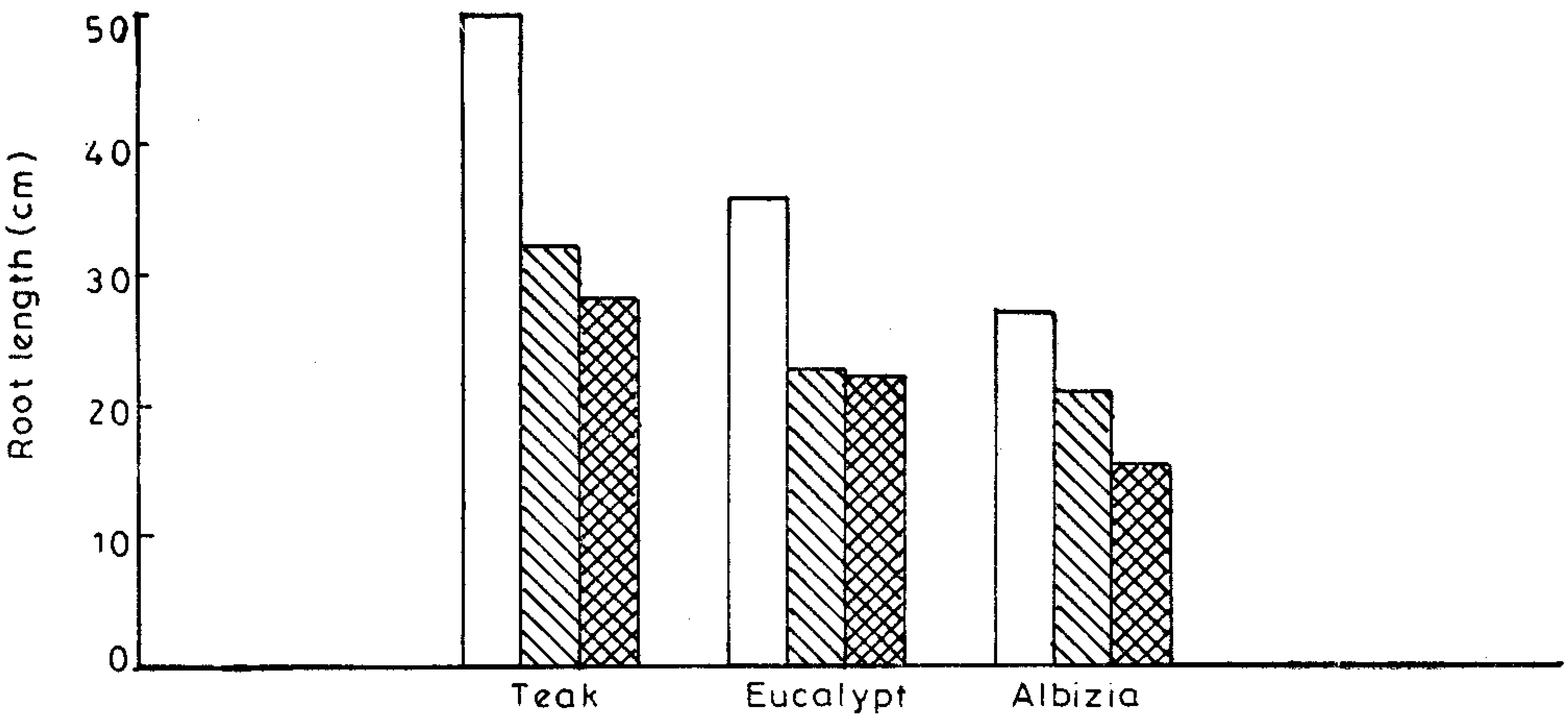


Fig.1. Effect of treatments on Root length

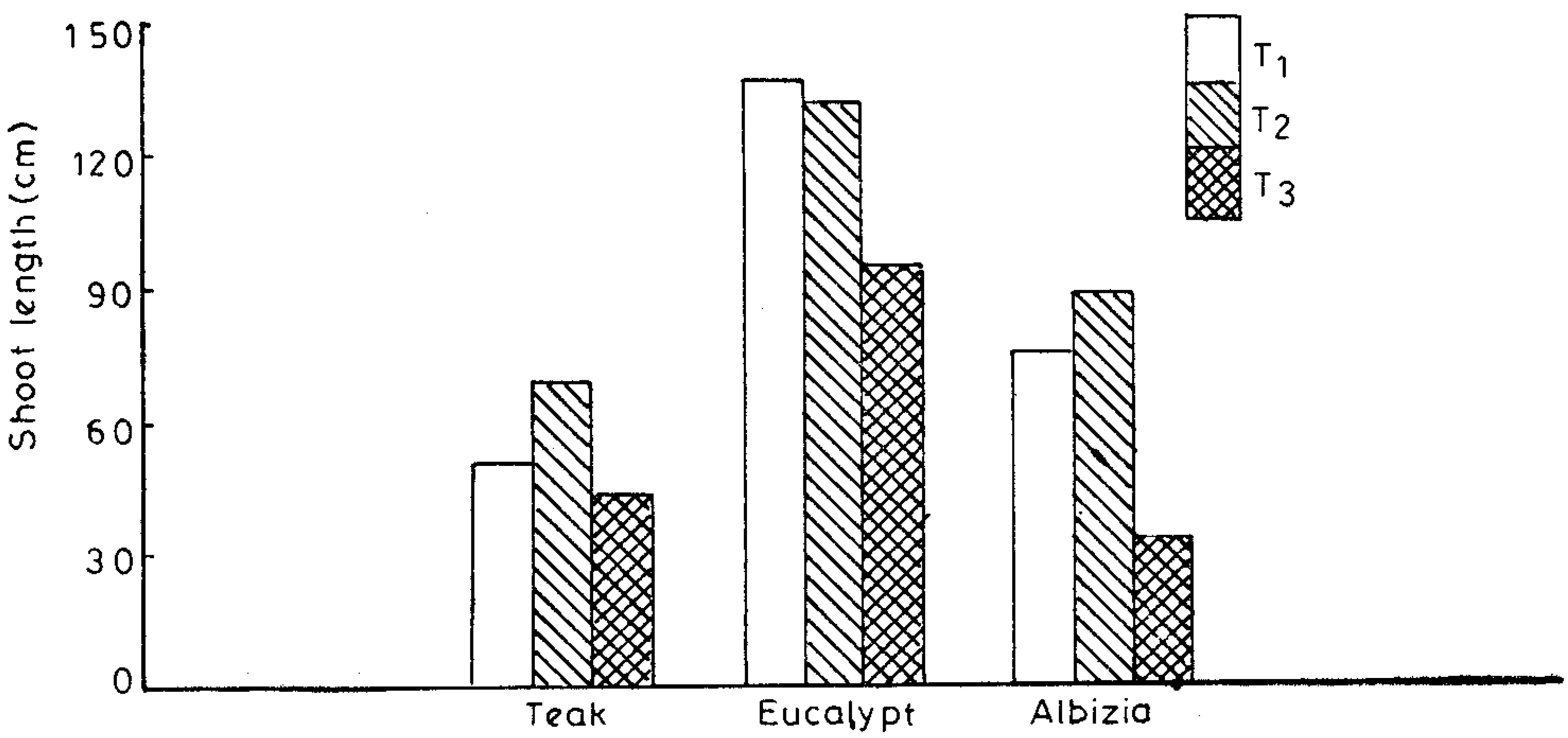


Fig.2 Effect of treatments on Shoot length

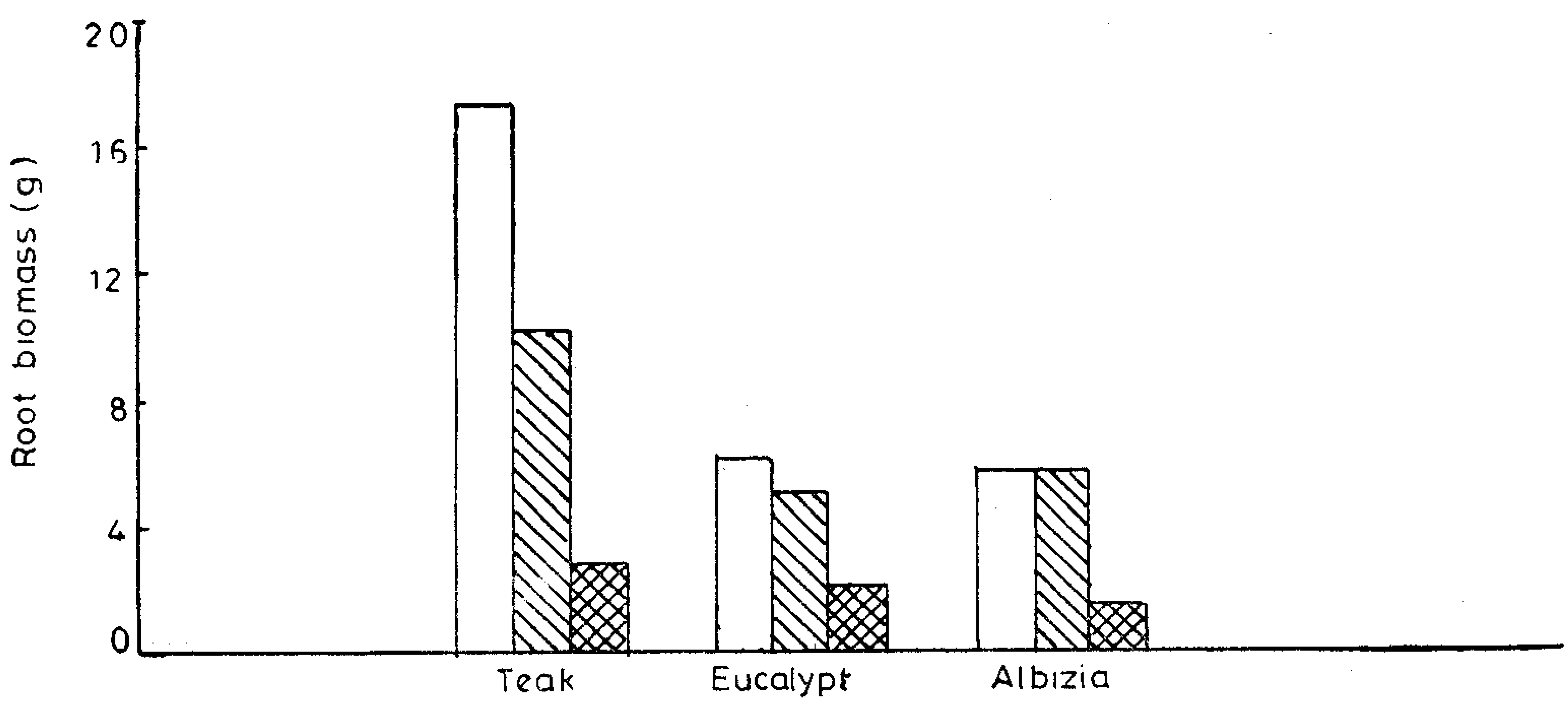


Fig.3. Effect of treatments on Root biomass

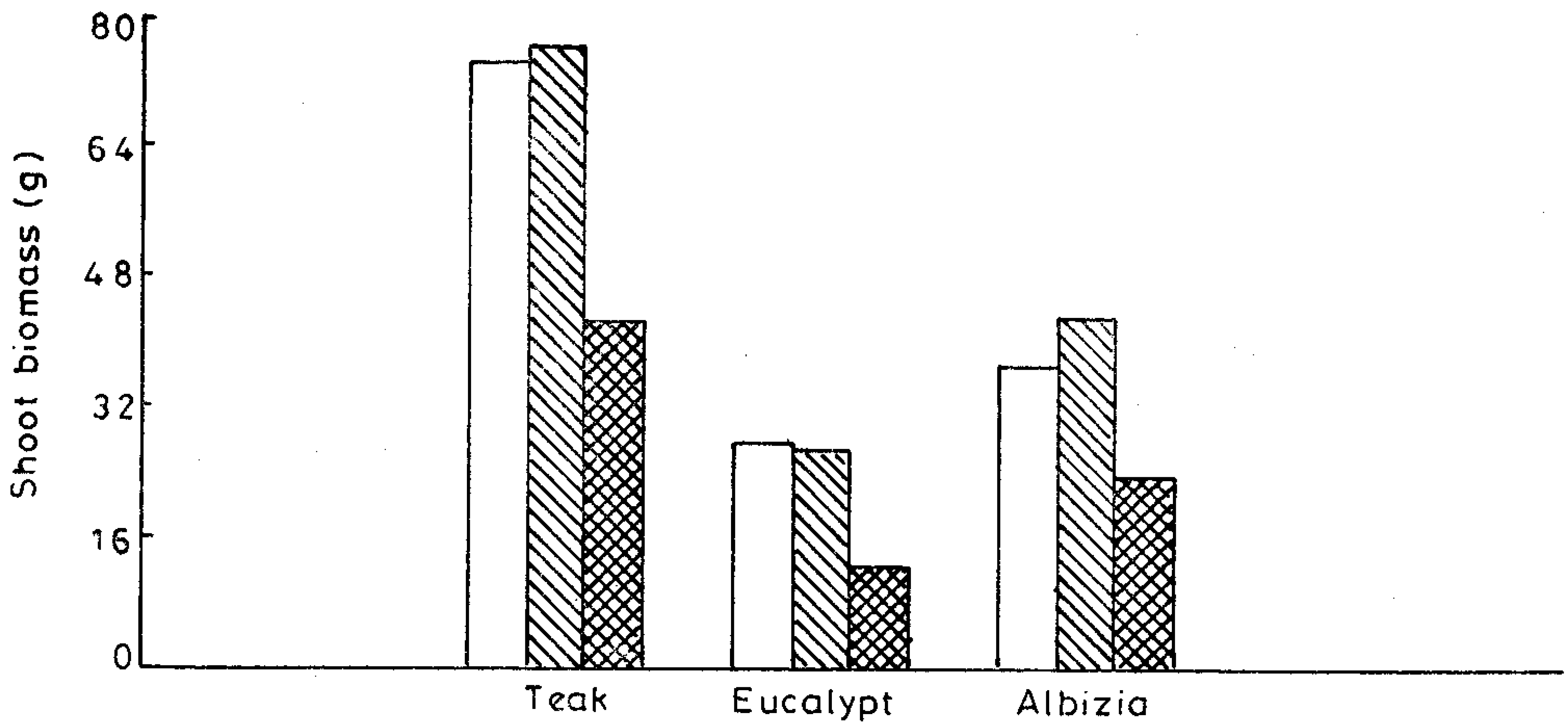


Fig.4. Effect of treatments on shoot biomass

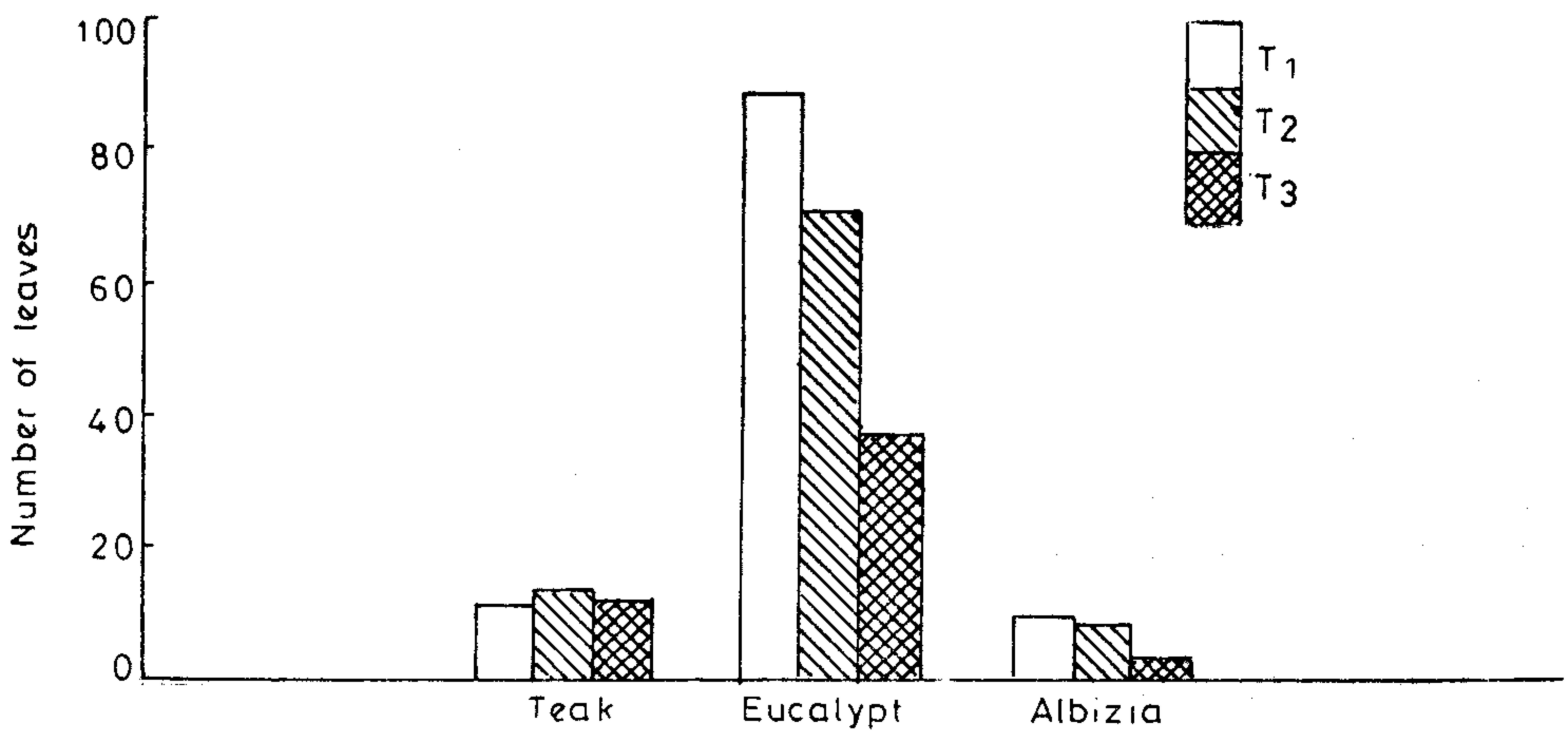


Fig.5. Effect of treatments on No of leaves

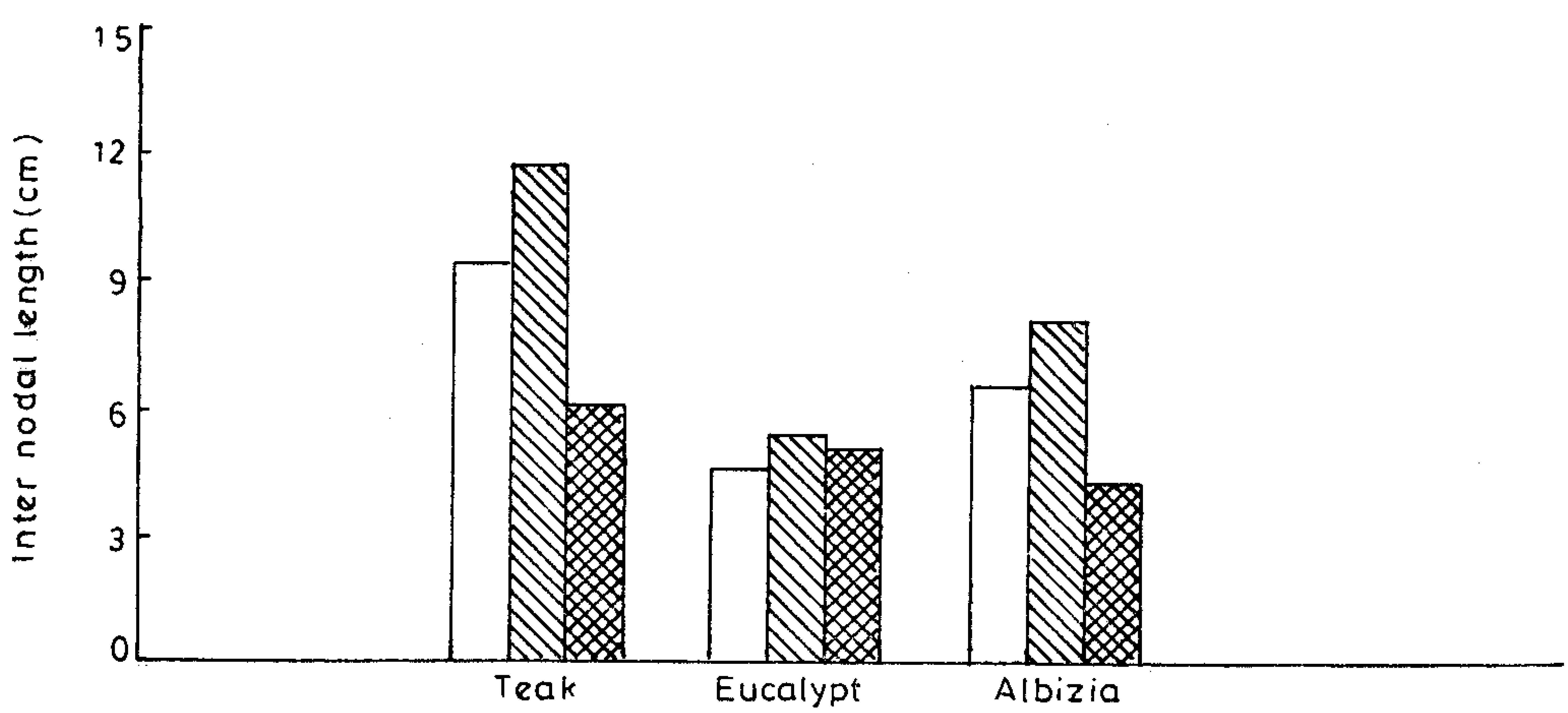


Fig.6 Effect of treatments on Internodal length

## Eucalypt

Root length of eucalypt was reduced significantly by $t_2$ (36%) in comparison with $t_1$ $t_2$ and $t_3$ did not differ in their effect on root elongation. Shoot length decreased very slightly (4%) by $t_2$ compared to $t_1$ and significantly by $t_3$, (29%) compared to $t_2$ Root biomass was reduced 18% by $t_2$ with respect to $t_1$ and further 58% by $t_3$ in relation to $t_2$ The second treatment did not produce any appreciable difference in shoot biomass production when compared to the first. But the third treatment brought about a significant reduction (54%) as compared with the second. There was a reduction of 20% in the number of leaves by $t_2$ as compared to $t_1$ $T_3$, further caused an appreciable reduction (48%) over $t_2$. Internodal length increased 17% by $t_2$ compared to $t_3$ while the reduction by $t_3$ over $t_2$ was not appreciable.

## Albizia

Root length of albizia showed a decrease of 21% by $t_2$ compared to $t_1$ and a further reduction of 27% by $t_3$ over $t_2$. Shoot length increased 19% by $t_2$ on comparison with $t_1$ and then decreased *63%* by $t_3$ as compared to $t_2$ There was no difference in the production of root biomass between the first and second treatments though $t_3$ produced a reduction of 74% as compared with $t_1$. Shoot biomass increased 15% by $t_2$ in comparison with $t_1$ and $t_3$ further reduced it by 45%. The second treatment produced a slight reduction (9%) in the number of leaves over $t_1$ and the third an appreciable decrease of 58% in relation to the second. Internodal length increased 23% by $t_2$ over t1 and then decreased 48% by $t_3$ in relation to $t_2$

## DISCUSSION

The results showed that root growth of all the three species was restricted by the mechanical impedance of the soil, though the level of soil compaction at which growth was markedly affected varied from species to species.

Root elongation of teak and eucalypt was significantly reduced by a soil bd of 1.4g $cm^{-3}$ while in the case of albizia significant reduction occurred only with 1.6g $cm^{-3}$ bulk density. Root biomass production decreased significantly only with a soil compaction level of 1.6g $cm^{-3}$ irrespective of species. Though root elongation was reduced by a bd of 1.49 $cm^{-3}$, their increase in girth and lateral root formation have occurred even beyond this level. Shoot length of teak was not affected significantly by treatments while shoot dry matter was significantly higher in $t_2$ In the case of eucalypt and albizia both length and biomass of shoot decreased significantly only with a soil bd of

$1.6g\ cm^{-3}$ . Number of leaves was significantly lower with $t_3$ in the case of eucalypt and albizia while no significant difference was observed in the case of teak. Internodal length differed significantly only between $t_2$ and $t_3$ for teak and albizia while eucalypt showed no significant difference between treatments.

Root and shoot growth of teak, eucalypt and albizia seedlings were reduced by soil compaction, while number of leaves and internodal length were not consistently affected.

When soils are compacted. the voids ratio is decreased. The air filled porosity is reduced and moisture tension increased. This is particularly true in the case of sandy loam soil since the finer soil separates can fit between coarser separates to cause very small pores and high levels of compaction (Gupta and Larson, 1979). Hence at a bd of $1.6g\ cm^{-3}$ the sandy loam soil utilised in this study might definitely have affected soil aeration and moisture availability. Reduction in root growth as a result would restrict the availability of water and nutrients which in turn would further reduce the growth of this tissue. All these will lead to the poor development and growth of the plant.

The results indicate the necessity for reducing soil bulk density while planting compacted sites with teak, eucalypt or albizia to ensure establishment and proper growth.

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