MUNICIPAL GARBAGE AS A COMPONENT OF POTTING MEDIA FOR SEEDLINGS OF SELECTED FOREST TREE SPECIES

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

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Dedicated

To

Abhilash

DECLARATION

I hereby declare that this thesis entitled **"MUNICIPAL GARBAGE AS A COMPONENT OF POTTING MEDIA FOR SEEDLINGS OF SELECTED FOREST TREE SPECIES"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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INTRODUCTION

INTRODUCTION

The burgeoning population, industrialisation and urbanisation, of late, has created a sequel of problems in India. The accumulation of wastes from a variety of sources have resulted in various forms of environmental threats and health hazards. Wastes including municipal garbage have polluted land, particularly cultivable land, water and air and in the long run, even the survival of human beings may be in perils.

Garbage is the domestic waste, a heterogenous and bulky material which includes the solid city wastes generated by human dwellings, biodegradable and non-biodegradable components such as glass, paper, plastics, leather, rubber, metals, peelings of kitchen vegetables, egg shells, remnants of food materials, used tea leaves stubble, leaves of garden plants etc. Garbage is also known as city refuse, municipal waste or refuse, domestic refuse etc.

Garbage has got very deleterious effect on environment. It has been established beyond doubt that garbage problems transcend traditional environmental boundaries and contribute to serious air, water and land pollution. Disposal problems of these garbage becomes difficult with increase in population density. In Kerala, because of small holdings and land area, disposal of solid waste has become all the more serious. The character of garbage have altered in line with rising living standards. Because of large number of industrial units in Kerala, it is estimated that about 30 per cent of the area near various industrial units have become unsuitable for crop cultivation and even for afforestation. Some of these wastes, if supplemented with small quantities of fertilisers is said to be good for raising some selected vegetables.

The system of raising tree seedlings in containers is widely practiced in social and agroforestry planting programmes in most parts of India. It is a well known fact that the potting media has got tremendous influence on growth and vigour of seedlings in the nursery. Though the effect of various constituents like sand, farm yard manure etc. on the growth of plants have been studied, the effect of garbage on growth have not been studied, particularly with regard to tree seedlings. Scientific information on the influence of waste materials on the growth behaviour, nutrient uptake, biomass production, chlorophyll production and leaf area will be extremely useful for the production of healthy seedlings at low cost.

Hence the present series of investigations were carried out in the College of Forestry with the objective to study the effect of different potting media containing fresh and decomposed garbage on growth and vigour of teak and mangium seedlings in the nursery. Production of healthy seedlings, same time, using the garbage is very relevant for a thickly populated fast developing state like Kerala.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Garbage is the term used internationally to describe waste materials arising from domestic, trade, commercial, industrial, agricultural and other related activities and from public services (Grey *et al.*, 1970). Garbage is not just waste, but is a valuable resource and a rich reliable source of plant nutrients which can increase the fertility of the soil (Thimmaiah, 1990).

2.1 Production of garbage

In India the annual waste generation is estimated to be about 7500 million tonnes (Doshi, 1995). Nearly 5000 tonnes of garbage is produced in Delhi alone. The per capita waste generation of about 150 gms/day in 1970's has now increased to the tune of over 500 gms/day (Tandon, 1992). The intensive farming practices generate abundant agricultural wastes to the tune of 280 million tonnes of organic residues (Tandon, 1992). Majority of the wastes are either disposed off or burned in many parts of the state.

2.2 Composition of garbage

Garbage is supposed to be a highly heterogenous medium (Muthaiah, 1984). Garbage comprise countless different materials like dust, food wastes, metal wastes, plastics, glass, discarded clothings and furnishings, garden wastes and even hazardous radio active wastes (Spooner, 1971). The composition of garbage varies with season, geographical situation, food habits and living styles and standards of the people (Baud and Schenk, 1994). They studied the physical composition of city refuse in different cities of India. In Calcutta, metals and stones are more, in Delhi paper content is more, in Bombay glassy and wooden loppings are more, and in Bangalore the fermentable materials such as vegetables and food matter are more. Belvins (1994) reported that in India food and vegetable wastes are more in the garbage whereas in western countries it contains more of paper followed by food materials. Gopinathan (1996) studied composition of solid waste of Thrissur municipality and found that biodegradable materials constitute 79.60 per cent of the refuse and this include mainly vegetables and fruit waste (18.10%), garden prunings (33.00%), paper boards (9.10%) and cellulose rich materials like bamboo baskets, hardwoods etc. (8.80%). Non biodegradable materials constitute 20.40 per cent of the refuse and this include mainly plastics (8.20%), metals (3.30%) and glass (3.20%). He also studied the physico-chemical properties of the effluent sludge from The Kerala Chemicals and Proteins Ltd. (KCPL) and found that it contained (1.13%) N, (5.60%) P, (0.31%) K, (21.30%) Ca and (14.30%) organic carbon.

2.3 Composting of garbage

Composting is a process wherein the larger particles are broken down to smaller ones by the action of soil micro and macro fauna (Krishna and Sreeramulu, 1983). Composting of garbage involves biological stabilization of solid matter either under aerobic or anaerobic conditions which will improve the nutrient content of the waste materials (Thambirajah and Kuthubutheen, 1989). The end product of composting is an organic material which could have beneficial use as a soil conditioner (Lund, 1971). Zorpass (1990) observed that composting of sewage sludge and garbage can enhance its quality and suitability for agricultural use. He also observed that predominance of cellulose and lignin substances delay the composting process since they can't be broken down easily by micro-organisms. Barrington *et al.* (1998) came into the conclusion that good aeration is an essential pre-requsite for good composting.

Lund (1971) reported that composting is a complex process which requires active association of bacteria, actinomycetes, fungi, earthworms, rotifers etc. Asha *et al.* (1997) evaluated the potential role of earthworm *Octochaetona serrata* on decomposition of kitchen vegetable refuse, cowdung, litter, cloth, paper and grasses and found that worm activity accelerated the decomposition of wastes by 19-60 per cent. Talashilkar (1998) studied the influence of earthworm activity on chemical properties during composting and found that there was a decrease in C:N ratio, while humic acid, cation exchange capacity and water soluble carbohydrates increased upto 150 days of composting.

2.4 Effect of garbage on soil organic matter content

Application of garbage increases the organic matter content of the soil. Organic matter will be subsequently decomposed by the activity of microorganisms which will finally improve the physical and chemical properties of soil (Gaur *et al.*, 1972). Application of composted garbage increases organic matter content and thereby check proliferation of plant parasitic nematodes (Gaur and Prasad, 1970). Works of Shanmugham and Ravikumar (1980) indicated an increase in organic carbon content of soil by the application of fresh garbage containing predominantly agricultural residues. Sainiz *et al.* (1998) noticed that addition of composted garbage lead to the increase of organic matter and this prevented mycorrhizal associations in many forest tree species. Preparation of organic manures from rural and urban wastes (Erbel, 1993, Paulraj and Sreeramulu, 1994 and Joshi, 1996); industrial wastes (Sogni, 1988, Menon *et al.*, 1989, Cabral and Vasconcelos, 1993 and Thampan, 1993) etc. provide valuable manure for maintaining the soil health. This will also help in the safe and hygienic disposal of solid wastes (Gaur *et al.*, 1995). Sikora and Yakovchenko (1996) observed that application of garbage composts to soil resulted increased mineralisation of soil organic matter and this has produced increased crop yields. Hernandez (1999) studied the effect of fresh and composted garbage on the organic matter content in an arid soil and found that organic matter content was high when the soil was supplemented with fresh garbage.

2.5 Effect of garbage on soil properties

Several studies threw light on the influence of composted garbage on soil properties. Gaur *et al.* (1978) reported that addition of garbage with nitrogen could reduce C:N ratio in the soil. Clarson (1983) reported an increase in available phosphorus content of the soil by the addition of garbage. Nassar (1998) observed that application of composted municipal garbage to soil increased the concentrations of N, P, K, Fe, Mn, Cu and Zn. The water holding capacity was also found to be increased. Khalilian and Sullivan (1997) found that garbage application reduced compaction of soil in top 30 cm. Rao and Shantaram (1995) observed that application of garbage to soil improved soil physical, chemical and biological properties. However, hazards of heavy metal accumulation caused phytotoxicity in the long run. Petrovic *et al.* (1996) observed that application of fresh municipal garbage to soil retards phosphorus availability due to the formation of insoluble metal complexes. Bellary *et al.* (1995) observed that paper sludge compost do not cause any change in soil properties, but it can be used as an organic amendment to the soil. Mbah and Ridli (1998) found that addition of composted garbage increased total porosity and water buffering capacity of the media. Saravanan and Baskar (1997) stated that incorporation of processed coir pith in potting media containing sand and coir pith in the ratio 1:1 improved its physicochemical properties by reducing the bulk density, particle density and pH and also improved the pore space, water holding capacity, total N content, organic carbon and available N, P and K.

Breslin (1999) reported that garbage application reduces leaching losses of nutrients from the surface soil to lower horizons. Pascal (1999) compared the efficiency of fresh and composted garbage for the improvement of soil quality and observed that the improvement was more evident in soils amended with composted residues in relation to those amended with fresh residues.

2.6 Effect of garbage on weed and disease control

Effect of garbage for controlling phytophthora disease in citrus plants has been reported by Widner *et al.* (1994). He observed that application of garbage to seedlings of citrus infested with *Phytophthora nicotiane* checked the spread of the disease and increased the rate of growth of seedlings. Severity of attack of *Rhizoctona solani, and Phytophthora capsici* in Capsicum was significantly reduced when soil was supplemented with municipal garbage and swine manure in the ratio 1:1 (Tuitert *et al.*, 1998). Raviv *et al.* (1998) observed that attack of *Fusarium oxysporum* was less in *Ocimum basilicum* when grown in a media containing municipal garbage and soil in equal proportions. Composts are reported to be very effective in controlling soil borne plant pathogen and even can be used as a substitute for methyl bromide. (Ceuster and Hoitink, 1998)

Ozores and Hampton (1999) reported that application of composted municipal garbage check germination of weed seeds like that of *Ipomea hederaceae, Pharbitis hederaceae* etc. Maynard (1998) evaluated the viability of using composted garbage to suppress weeds and found that it was very effective in the suppression of weeds of field grown forest nursery stock.

2.7 Effect of waste materials as a component of potting media on growth of seedlings

2.7.1 Garbage as a component of potting media

The effect of potting media containing municipal garbage on the growth performance of seedlings have been widely studied. Gopinathan (1996) observed better performance of seedlings of bhindi when grown in a medium containing soil, composted coir pith and decomposed garbage. A nursery study conducted at College of Forestry, Vellanikkara to compare the effect of different potting media on the growth and vigour of seedlings showed that all treatments except soil and vermiculite resulted in better growth of seedlings. Seedlings of *Artocarpus hirsutus* recorded maximum height when grown in a mixture of soil and sand (Ani, 1992). Trivedi and Ray (1985) stated that garbage with paper pulp contains lot of aldyhydes and phenols which are reported to affect the growth of different species of vegetable crops. They observed that waste materials from textile and building construction also significantly affected the growth of plants. Radha and Panigrahi (1998) found that application of 15 to 25 per cent solid waste collected from the dump of a Chloralkali factory retarded seedling growth of rice in pot experiments. There was a marked stimulation of root length and fresh weight at 5 per cent concentration, but little effect was observed on shoot growth. Shibli *et al.* (1999) observed that increase in concentration of municipal garbage compost in the *in vitro* cultures of tomato and apple grown on Murashige and Skoog medium resulted a gradual increase in the number and length of roots. Karagiannidis (1994) found that use of industrial garbage which contains MnO_2 at the rate of 500 to 600 tons per hectare improved maize production by eight fold and sunflower seed yield by four fold. Khalilian and Sullivan (1997) reported that in cotton, application of municipal solid waste compost at the rate of 15 tons per acre resulted an increase in seed yield to the tune of 167 lb per acre.

Euselro *et al.* (1984) studied the viability of using bark waste and saw dust as potting media and observed that a potting mixture of saw dust and soil in equal proportion significantly influenced the growth of seedlings of *Albizia* *falcataria* and Pterocarpus species, when compared to saw dust or bark waste alone. Goswami (1990) observed that an equal proportion of soil, sand and composted garbage was found to be most effective for better rooting percentage, root number and length of roots in mangium seedlings. Skoupy (1980) reported that an equal mixture of composted bark and soil promoted better growth in Douglas fir and larch seedlings. An increase in the proportion of composted bark to the tune of 3:1 gave poor results possibly owing to nutritional deficiency.

2.7.2 Coir pith as a component of potting media

The question of considering waste material like coir pith as a source of organic material to soil attracted the attention of researchers since many years. Coir pith with about 30 per cent carbon and a C:N ratio of 112:1 which is presently available in abundance can be a good source of carbon especially under tropical climatic conditions (Joseph, 1995). Coir pith has low bulk density (0.1525 g cc^{-1}), low particle density (0.49 g cc^{-1}) and low thermal conductivity (Ravindranath, 1991). Raw coir pith contains 1.28 per cent fats and resins and 7.9 per cent ash (Satyanarayana *et al.*, 1984). It is rich in lignin (30 per cent) and cellulose (26.5 per cent) (Ravindranath, 1991).

There are several constraints in using raw coir pith as a component of potting media. Composition wise, raw coir pith is low in nitrogen and phosphorus with wide C:N ratio (Bopaiah, 1991). Its low biodegradability also limits its application to field crops (Fan *et al.*, 1984). Saravanan *et al.* (1991) reported that coir pith is generally slightly acidic in nature. Singaran and Pothiraj (1991) stated that raw coir pith has high lignin content, and may not be advantageous for continuous application. Joseph (1993) observed that the simplest way to convert coir pith into organic manure is by composting. Coir pith decomposed for a period of four months were reported to have dual advantage of high moisture retention and good nutritional status (Moorthy *et al.*, 1996). According to Gaur *et al.* (1980), composting of coir pith could increase the availability of N and K and hence could be used as one of the potting media for raising nursery plants. Growth and vigour of Ailanthus and Albizia seedlings were not found to be affected significantly by the use of coir pith as one of the components in the nursery bed (Sudhakara, 1997).

2.8 Performance of tree species on media containing waste materials

Species specificity with respect to growth medium was evident from a series of studies. Donald and Visser (1989) showed that survival and growth of seedlings of *Acacia meansii* was significantly reduced by vermicompost. Survival of *Pinus patula* seedlings was not affected by vermicompost, but growth in later stages was found to be reduced. Suguki (1990) explained that with respect to *Eucalyptus camaldulensis*, germination and growth in terms of height were greater when grown in a potting mixture of soil, sand, garbage and cowdung compared to other combinations. Maithani *et al.* (1988) studied the effect of different rooting media on seed germination and seedling growth. They found that growth of *Acacia nilotica* was found to be slightly higher when grown in a mixture of sand, soil and FYM in 1:2:1, 1:3:1 and 1:1:1 proportions compared to forest soils alone.

Devaranavadagi and Sajjan (1997) studied the effect of various potting media on seedling emergence and vigour index of *Acacia nilotica*. The potting media containing tank silt, black sand and farm yard manure at a ratio of 1:3:1 was found to be most promising. Sandanam *et al.* (1992) studied the suitability of rooting media containing forest soil, sand and garbage in different proportions for raising *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* seedlings. Du and Lei (1984) observed that a mixture containing humus, soil, saw dust, waste supplemented with horse manure resulted in better growth of *Acacia confusa* seedlings.

Simpson (1985) reported that a medium with vermiculite, municipal garbage and soil at 1:1:1 proportion resulted in the production of high quality seedlings of *Pinus contorta, Picea glauca* and *Abies lasciocarpa*. Mohan *et al.* (1991) found that a combination of soil, sand and FYM in the ratio 1:1:1 increased the height and dry matter production of seedlings of *Swietenia macrophylla* and *Dalbergia latifolia*. Beniwal and Dhawan (1991) observed maximum germination and growth of seedlings of *Anthocephalus chinensis* when sown in soil containing garbage and farm yard manure at 1:1 proportion. Bharadwaj *et al.* (1986) found that an equal mixture of soil, sand and composted garbage was most ideal for growth of *Pinus roxburghi* seedlings.

Skolmen and Roo (1986) observed that potting mixtures containing garbage with plastic and paper resulted in complete death of seedlings. Pawuk (1981) observed that long leaf and short leaf pines have grown equally well in a medium consisted of composted garbage of low pH and soil in the ratio 1:2. Firda and Havelkar (1982) studied the scope of utilising crushed waste bark for the preparation of potting media and they found that this was not promising. Yadav *et al.* (1982) observed that growth of teak was better in a medium containing black soil, sand and garbage in (1:1:1) proportion. Singh and Sharma (1983) reported that addition of composted garbage (25, 50, 75 and 100 per cent) to nursery soils improved the growth of spruce and fir seedlings, sametime it reduced the root:shoot ratio in spruce but not in fir.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigations were carried out at the College of Forestry, Kerala Agricultural University, Vellanikkara with an objective to study the effect of municipal garbage as a component of potting media on the growth and vigour of seedlings of *Acacia mangium* Willd. (mangium) and *Tectona grandis* Linn.F (teak). These two species are very important in most of the states in South India, particularly Kerala and are widely grown by farmers. These are also recommended for extensive planting programmes in social/agroforestry systems and plantation forestry programmes in waste lands and coastal areas.

The study site lies between 10° 32' N latitude and 76° 26' longitude. The climate is warm humid with an average annual rainfall of 3000 mm. The temperature variation during the day is not wide. The soil is of laterite origin.

3.1 Collection of seeds

Seeds of both the species were collected during the month of May. Ripened pods of mangium were collected from the full grown trees maintained in the instructional farm of College of Forestry. The pods were uniformly spread over cement floor for 3 to 4 days to allow them to dry thoroughly. The seeds were extracted manually by breaking open the pods. Teak seeds were collected from Nilambur forest area. Healthy and completely matured seeds were cleaned and dried for 3 to 4 days and used for the study. Seeds were put in clean gunny bags and stored at ambient temperature.

3.2 Raising of seedlings

Seeds were subjected to pretreatment. Mangium seeds were put in boiling water for five seconds followed by soaking in cold water for 30 minutes, while alternate wetting and drying was followed for teak seeds. The seeds, after subjecting to pre treatment were sown in the nursery beds. Uniform vigorous seedlings of one month old were planted in 200 gauge poly bags of 30 x 40 cm size filled with different treatment media containing garbage and arranged in separate lines in the nursery (Plates 1, 2 and 3).

3.3 Collection of garbage and preparation of potting media

Garbage was collected from municipal drenching sites (Plate 4). Maximum care was taken to collect fresh garbage representing all sorts of waste materials. This was brought to the College and used for various treatments. Materials like plastics, stones and glass pieces were removed from garbage before it is used for preparing the potting media. A portion of this garbage was kept open to facilitate decomposition.

The following potting media were tried for the study. The components were mixed on (v/v) basis.

1. Soil alone
2. Soil : sand (1:1 ratio)
3. Soil : sand : cow dung (1:1:1 ratio)
4. Soil : sand : fresh garbage (1:1:1 ratio)
5. Soil : sand : two week decomposed garbage (1:1:1 ratio)
6. Soil : sand : one month decomposed garbage (1:1:1 ratio)

Plate 1. A view of the experimental plot

Plate 2. One month old teak seedling used for the experiment

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Plate 3. One month old mangium seedling used for the experiment

Plate 4. The drenching spot with municipal garbage and waste

The experiment was laid out in Completely Randomised Design (CRD) with four replications. A total number of one thousand two hundred seedlings were maintained in the field as a part of the study.

3.4 After care of seedlings

The seedlings, after transplanting to the poly bags were kept under partial shade. Watering was done daily. Necessary plant protection measures were also adopted.

3.5 Main items of observation

3.5.1 Survival rate of seedlings

Initial establishment after one month of planting and final survival after six months were recorded.

3.5.2 Shoot growth observations

The following shoot observations were recorded at fortnightly intervals.

3.5.2.1 Height of seedlings

The height of seedlings was measured using a metre scale from the collar portion upto terminal bud and expressed in centimeters.

3.5.2.2 Collar girth

The collar girth of the seedlings was measured with a vernier caliper and expressed in millimeters.

3.5.2.3 Leaf area

The leaf area was recorded using leaf area meter.

3.5.3 Root observations

Representative seedlings were uprooted at monthly intervals and the following root observations were made.

3.5.3.1 Length of roots

The length of roots was measured using a metre scale from the collar portion to the tip of the tap root and expressed in centimeters.

3.5.3.2 Spread of roots

Spread of the roots in various directions was measured and average spread was worked out and expressed in centimeters.

3.5.3.3 Number of roots

Number of primary and secondary roots produced by individual seedlings was recorded.

3.5.4 Biomass

3.5.4.1 Fresh weight of shoot

Representative seedlings were sampled from each treatment at monthly intervals for estimation of biomass. The shoot and root portion of the seedlings were separated. The fresh weight of shoot portion was determined separately using a precision balance.

3.5.4.2 Dry weight of shoot

After finding out the fresh weight, the shoot portion was dried in hot air oven at a temperature of 60° to 80°C for about 24 to 48 hours. The dry weight was taken and recorded. The drying and weighing was repeated till constant weights were obtained.

3.5.4.3 Fresh weight of root

Roots were separated carefully from the plant, washed well and the weights were recorded using a precision balance.

3.5.4.4 Dry weight of root

The dry weight was found out after oven drying the sample at 60° to 80°C. This was repeated till constant weights were obtained.

3.5.5 Biochemical analysis

3.5.5.1 Chlorophyll content

Chlorophyll content of the leaf was estimated following the method suggested by Starner and Hardley (1967). Leaf samples were collected from the selected plants, cut into pieces, 0.1 gm of the sample was weighed into a mortar and ground with pestle to extract the chlorophyll using 80 per cent acetone. The extract was filtered using Whatman No.1 filter paper and made upto 25 ml using 80 per cent acetone. The absorbance was read at wave lengths of 663 nm and 645 nm using a spectrophotometer. The chlorophyll 'a' chlorophyll 'b' and total chlorophyll content of each sample was calculated using the following formulae.

Chlorophyll 'a' ($mg\ g^{-1}$ of tissue)

$$= \frac{12.7\ (\text{OD at 663 nm}) - 2.69\ (\text{OD at 645 nm})}{1000 \times W} \times V$$

Chlorophyll 'b' ($mg\ g^{-1}$ of tissue)

$$= \frac{22.9\ (\text{OD at 645 nm}) - 4.68\ (\text{OD at 663 nm})}{1000 \times W} \times V$$

Total chlorophyll (mg g^{-1} of tissue)

$$= \frac{20.2\ (\text{OD at 645 nm}) + 8.02\ (\text{OD at 663 nm})}{1000 \times W} \times V$$

where OD - Optical density

V - Final volume of 80 per cent acetone extract

W - Fresh weight of tissue in gms.

3.5.6 Chemical analysis

Every month, representative seedlings from each replication were randomly selected. The samples, after drying were powdered. The fine powder was used for the estimation of various nutrient elements. The following nutrients were analysed.

3.5.6.1 Nitrogen

Nitrogen content in fresh samples was determined by digesting 0.1 g of sample in 5 ml of concentrated sulphuric acid using digestion mixture (sodium sulphate : Copper sulphate in 10:4 ratio) and nitrogen in the digest was determined by Kjeldhal's method (Jackson, 1958).

3.5.6.2 Phosphorous

One gram of the powdered sample was digested in triacid mixture (Nitric acid:Sulphuric acid:perchloric acid in 10:1:3 ratio) and the digest was made up to 100 ml. A known quantity of aliquot was taken to determine the phosphorus content calorimetrically by the vanado molybedo phosphoric yellow colour method (Jackson, 1958). The colour intensity was read at a wave length of 470 nm in UV spectrophotometer.

3.5.6.3 Potassium

A known quantity of aliquot from the triacid extract was taken to read potassium using flame photometer (Jackson, 1958).

3.6 Statistical Analysis

Treatment means were analysed statistically by applying the techniques for analysis of variance for CRD as suggested by Snedecor and Cochran, (1967). All the biometric observations were also analysed statistically.

RESULTS

RESULTS

The results of investigation carried out at the College of Forestry, Vellanikkara with an objective of finding out the effect of various potting media containing garbage on the growth and vigour of teak (*Tectona grandis* Linn F.) and mangium (*Acacia mangium* Willd) seedlings in the nursery are furnished below.

4.1 Effect of potting media on survival rate of seedlings

The observations on initial survival rate after one month and final survival rate after six months of planting of seedlings of teak and mangium are given in Tables 1 and 2, respectively.. It is clear from the data that the two treatments, T_1 (soil alone) and T_2 (soil : sand) recorded 100 per cent initial survival rate in the case of teak. Here all the treatments recorded a survival rate of over 95 per cent. Based on the survival rate, the treatments could be ranked as T_1=T_2> T_3 > T_5 > T_6> T_4.

In the case of mangium also the treatment T_2 (soil : sand) showed 100 per cent initial survival rate. The treatment T_4 (soil : sand : fresh garbage) showed maximum mortality of 38 per cent and this was followed by T_5 (soil : sand : 2 week decomposed garbage-20%), T_6 (soil : sand : 1 month decomposed garbage - 18%), T_3 (soil : sand : cow dung - 8%) and T_1 (soil alone - 6%).

It is also evident from the data that the treatment T_2 (soil : sand) which showed highest initial survival rate in teak and mangium retained the same trend

Table 1. Initial and final survival rate of teak seedlings as influenced by different potting media.

Treatment number	Treatment details	Survival percentage	
		Initial (after 1 month)	Final (after 6 months)
T_1	Soil alone	100	87
T_2	Soil : Sand (1:1)	100	92
T_3	Soil : Sand : Cow dung (1:1:1)	98	86
T_4	Soil : Sand : Fresh garbage (1:1:1)	95	81
T_5	Soil : Sand : 2 week composed garbage (1:1:1)	97	90
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	96	89

Table 2. Initial and final survival rate of mangium seedlings as influenced by different potting media.

Treatment number	Treatment details	Survival percentage	
		Initial (after 1 month)	Final (after 6 months)
T_1	Soil alone	94	71
T_2	Soil : Sand (1:1)	100	84
T_3	Soil : Sand : Cow dung (1:1:1)	92	69
T_4	Soil : Sand : Fresh garbage (1:1:1)	62	53
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	80	59
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	82	64

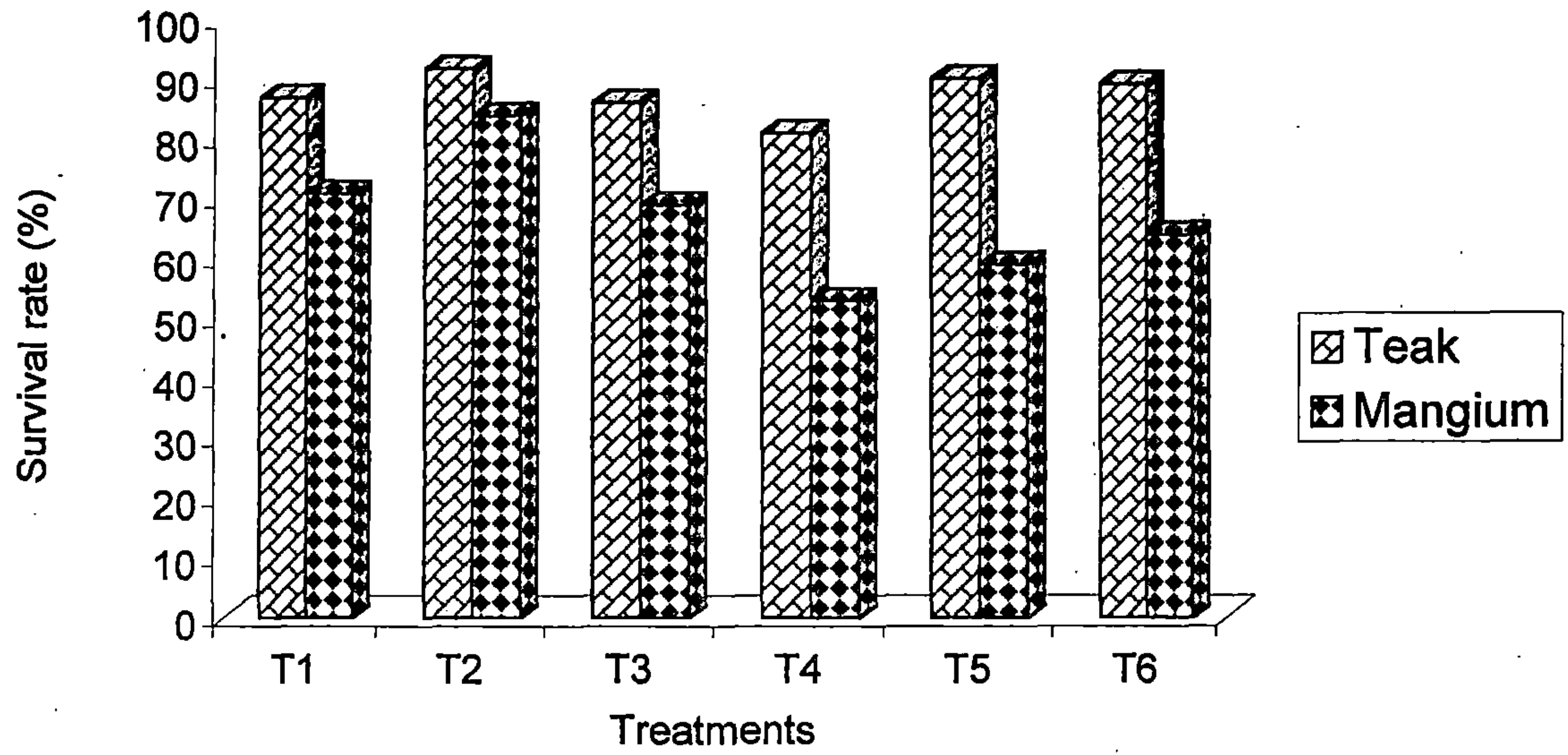


Fig. 1. Survival rate of teak and mangium seedlings after six months of planting as influenced by different potting media

towards the end of the study. In the case of teak, lowest final survival rate was observed for T_4 (soil : sand : fresh garbage - 81%) followed by T_1 (soil alone - 87%), T_6 (soil : sand : 1 month decomposed garbage - 89%) and T_5 (soil : sand : 2 week decomposed garbage - 90%).

The data furnished in Table 2 also reveal that in the case of mangium, lowest final survival rate was observed for T_4 (soil : sand : fresh garbage - 53%) followed by T_5 (soil : sand : 2 week decomposed garbage - 59%), T_6 (soil : sand : 1 month decomposed garbage - 64%), T_3 (soil : sand : cow dung - 69%) and T_1 (soil alone - 71%). The final survival rate i.e., survival rate of seedlings after six months of planting of both the species are also illustrated in Figure 1.

4.2 Effect of potting media on shoot growth parameters

The observations on various shoot growth parameters of seedlings as influenced by potting media containing fresh and decomposed garbage are furnished in Tables 3 to 10.

4.2.1 Height

In teak, the treatments differed significantly with regard to growth of seedlings (Table 3 and Plate 5). At the end of the study i.e., at the end of the twelth fortnight, the treatment T_3 (soil : sand : cow dung) recorded maximum height of 42.9 cm which was followed by T_6 (soil : sand : 1 month decomposed garbage - 39.25 cm), T_5 (soil : sand : 2 week decomposed garbage - 33.69 cm), T_4 (soil : sand : fresh garbage - 28.52 cm) and T_2 (soil : sand), where the average height was

Table 3. *Effect of potting media on height (cm) of teak seedlings at fortnightly intervals.*

Treatment number	Treatment details	Fortnights											
		1	2	3	4	5	6	7	8	9	10	11	12
T_1	Soil alone	6.63	6.90	7.35	7.88	8.67	9.65	11.90	13.53	16.00	17.85	19.88	22.60
T_2	Soil : Sand (1:1)	7.75	8.20	8.83	9.70	11.38	13.00	15.05	16.65	19.18	21.63	24.28	26.85
T_3	Soil : Sand : Cow dung (1:1:1)	13.30	15.18	17.58	20.75	22.08	25.89	28.80	30.56	34.90	38.70	41.40	42.90
T_4	Soil : Sand : Fresh garbage (1:1:1)	8.35	8.85	9.45	10.95	13.26	15.21	17.45	19.68	22.90	25.45	27.90	28.52
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	9.70	10.28	11.35	12.48	14.30	16.98	20.25	23.19	27.15	29.67	31.28	33.69
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	11.40	12.23	13.80	15.75	17.33	20.26	23.79	26.80	30.38	34.01	36.97	39.25
	F test	**	**	**	**	**	**	**	**	**	**	**	**
	SEm±	0.36	0.35	0.34	0.41	0.56	0.72	0.79	0.82	0.97	1.11	1.05	1.20
	CD(0.05)	1.069	1.040	1.069	1.218	1.563	2.038	2.340	2.395	2.940	3.297	3.119	3.264

** Significant at 1 per cent level

Plate 5. Variation in height of teak seedlings at the end of the study as influenced by different potting media

T_1 = Soil alone

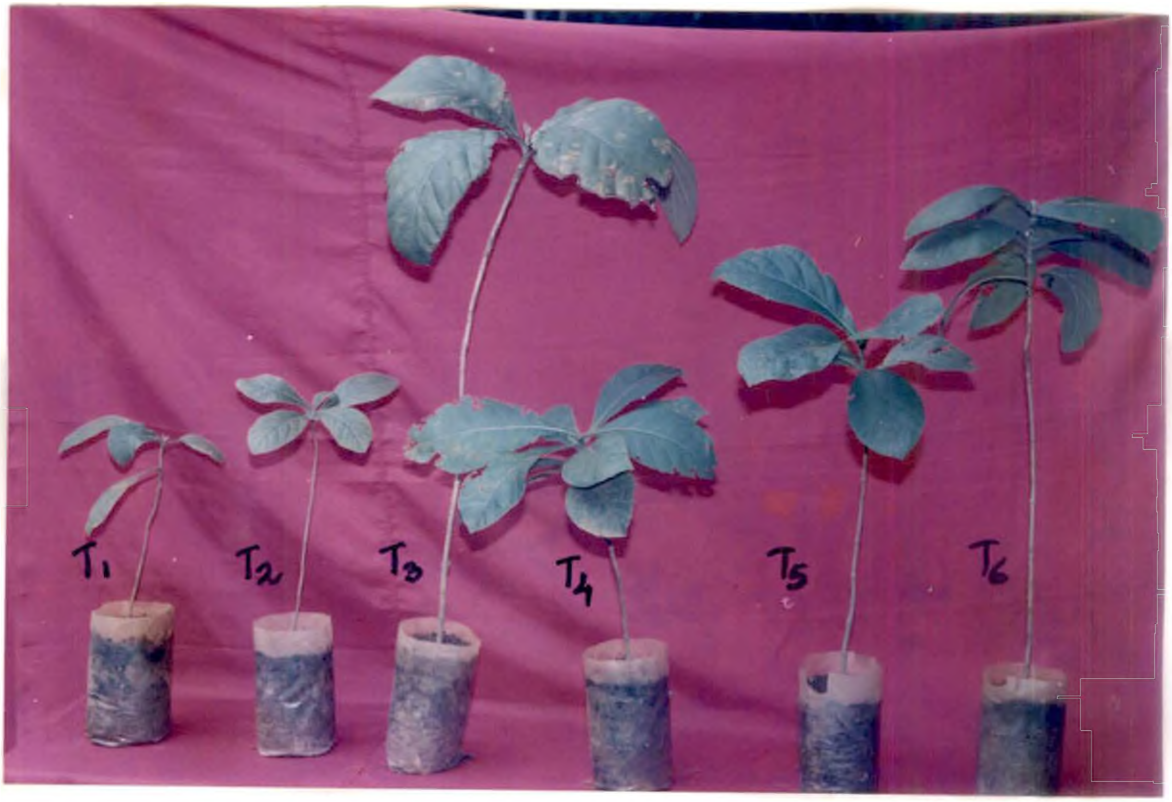
T_2 - Soil:sand (1:1 ratio)

T_3 - Soil:sand:cow dung (1:1:1 ratio)

T_4 - Soil:sand:fresh garbage (1:1:1 ratio)

T_5 - Soil:sand:two week decomposed garbage (1:1:1 ratio)

T_6 - Soil:sand:one month decomposed garbage (1:1:1 ratio)


T1
T2
T3
T4
T5
T6

26.85 cm. The treatment T_1 (soil alone) recorded the least height of 22.60 cm. It could be seen from the table that till the fourth fortnight, the treatments T_2 and T_4 were on par with regard to the growth parameter. The treatment T_3 (soil : sand : cow dung) recorded maximum height growth between the eighth and tenth fortnights. At the twelth fortnight, i.e., at the end of the study, the treatments T_2 (soil : sand) and T_4 (soil : sand : fresh garbage) are found to be on par with each other. Similarly from the eleventh fortnight onwards, treatments T_3 (soil : sand : cow dung) and T_4 (soil : sand : fresh garbage) showed a decreasing trend in height growth with regard to the total height increment over the period. A close perusal of the data reveal that the treatment T_3 (soil : sand : cow dung) recorded the maximum total increment in height (29.6 cm) whereas minimum was by T_1 (soil alone) where it was only 15.97 cm. Effect of various treatments on fortnightly increase in height of teak seedlings is also depicted in Figure 2.

In the case of mangium also, the treatments did exert significant effect on height growth of seedlings as is evident from the data furnished in Table 4, illustrated in Figure 3 and depicted in Plate 6. At the end of the sixth month, the treatment T_3 (soil : sand : cow dung) recorded maximum height of 62.91 cm followed by T_6 (soil : sand : 1 month decomposed garbage - 57.39 cm), T_5 (soil : sand : 2 week decomposed garbage - 44.83 cm), T_2 (soil : sand - 43.60 cm), T_4 (soil : sand : fresh garbage - 40.38 cm) and T_1 (soil alone - 37.60 cm). From the second to the ninth fortnights, the two treatments T_3 (soil : sand : cow dung) and T_6 (soil : sand : 1 month decomposed garbage) were found to be on par. Similarly during the

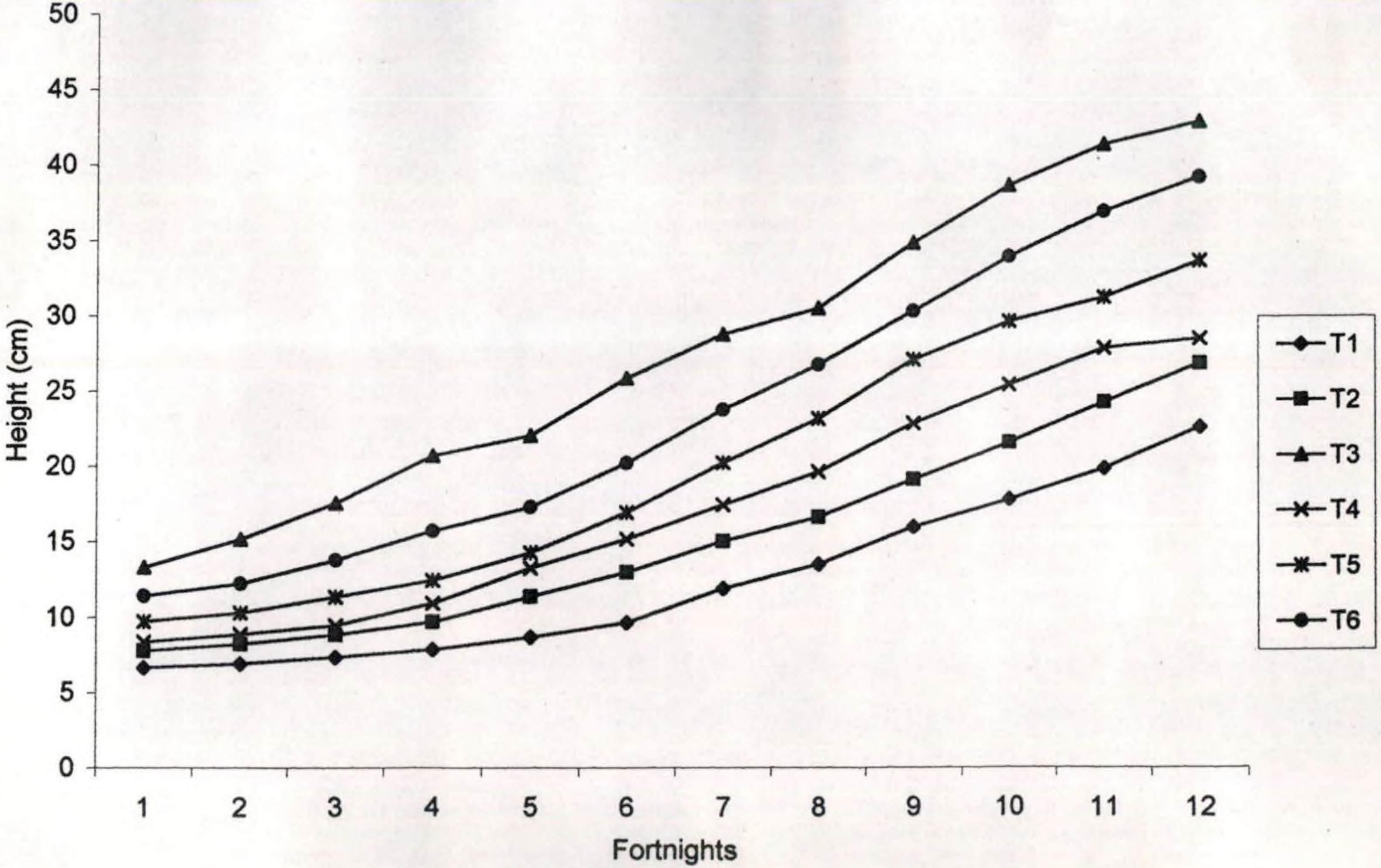


Fig. 2. Effect of potting media on height of teak seedlings at fortnightly intervals

Table 4. Effect of potting media on height (cm) of mangium seedlings at fortnightly intervals

Treatment number	Treatment details	Fortnights											
		1	2	3	4	5	6	7	8	9	10	11	12
T_1	Soil alone	9.65	11.43	13.03	14.70	16.95	19.40	22.55	25.48	28.43	31.65	34.40	37.60
T_2	Soil : Sand (1:1)	12.78	14.25	16.50	18.78	21.40	24.33	27.03	30.70	34.25	38.19	41.02	43.60
T_3	Soil : Sand : Cow dung (1:1:1)	14.53	17.95	20.58	24.60	27.60	31.90	36.70	41.40	47.02	52.60	56.75	62.91
T_4	Soil : Sand : Fresh garbage (1:1:1)	11.98	12.49	13.10	14.65	16.32	20.05	24.13	27.68	31.98	33.43	36.94	40.38
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	12.60	14.88	16.12	18.79	22.30	25.90	27.69	30.20	34.70	38.32	42.34	44.83
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	13.12	16.79	19.84	23.40	27.20	30.92	34.82	39.34	44.21	47.69	52.64	57.39
	F Test	**	**	**	**	**	**	**	**	**	**	**	**
	SEm±	0.28	0.54	0.53	0.55	0.67	0.98	1.04	1.05	1.07	1.19	1.16	1.33
	CD (0.05)	0.832	1.604	1.574	1.634	1.990	2.911	3.089	3.082	3.119	3.434	3.432	3.950

** Significant at 1 per cent level

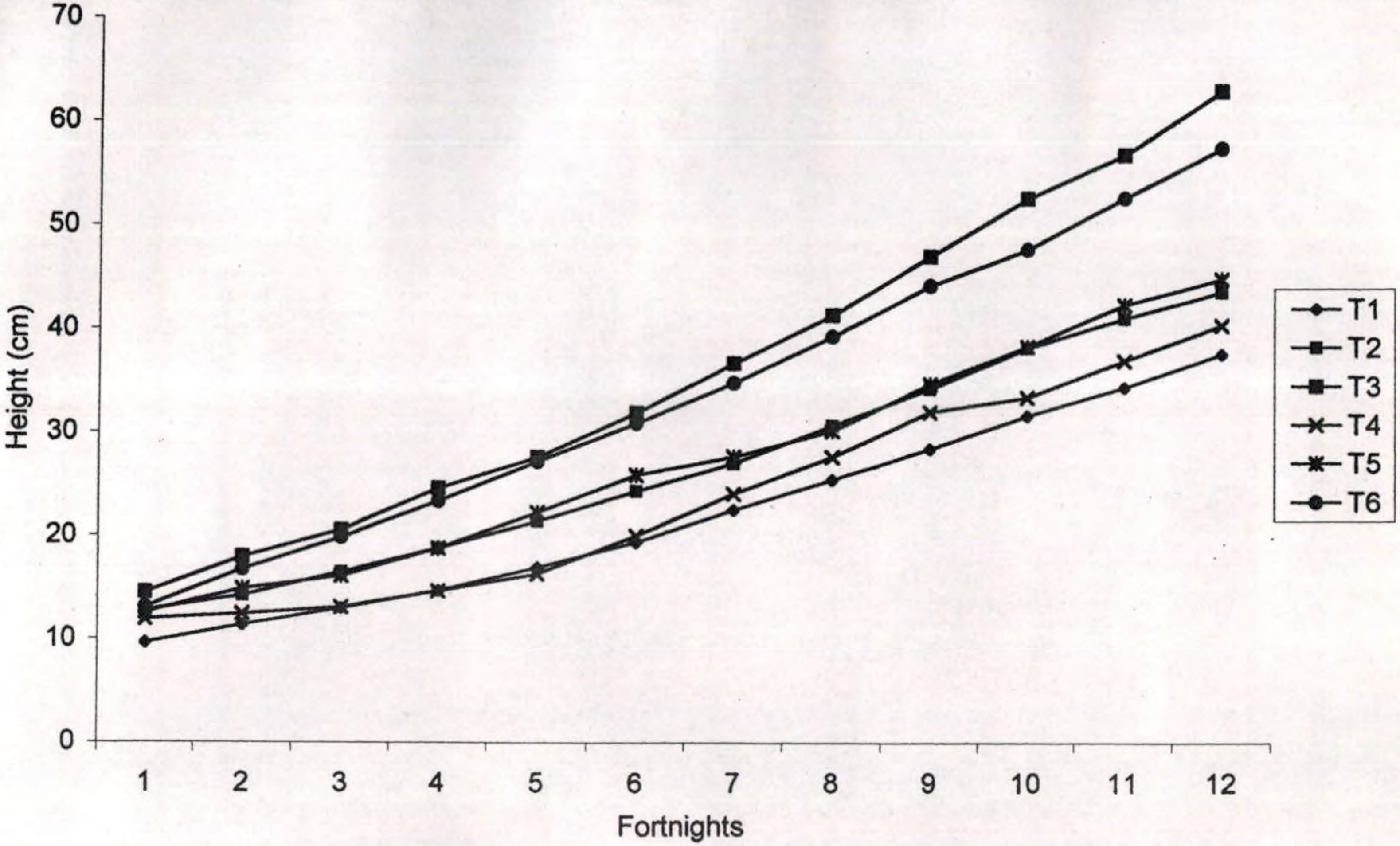


Fig. 3. Effect of potting media on height of mangium seedlings at fortnightly intervals

Plate 6. Variation in height of mangium seedlings at the end of the study as influenced by different potting media

T_1 - Soil alone

T_2 - Soil:sand (1:1 ratio)

T_3 - Soil:sand:cow dung (1:1:1 ratio)

T_4 - Soil:sand:fresh garbage (1:1:1 ratio)

T_5 - Soil:sand:two week decomposed garbage (1:1:1 ratio)

T_6 - Soil:sand:one month decomposed garbage (1:1:1 ratio)

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first fortnight, treatments T_5 (soil : sand : 2 week decomposed garbage) was found to be on par with T_6 (soil : sand : 1 month decomposed garbage). In general, maximum growth in height occurred for all the treatments during the second half of the study period i.e., from the sixth to the twelth fortnight. In the case of mangium also, the treatment T_3 (soil : sand : cow dung) recorded the maximum total height increment (48.38 cm) and minimum increment of 28.4 cm was recorded by the treatment T_4 (soil : sand : fresh garbage).

4.2.2 Collar girth

Unlike height, the treatments did not exert any significant influence on the collar girth of teak seedlings during the first two fortnights. However, from the third fortnights onwards, significant influence was observed. At the end of the study, treatment T_3 (soil : sand : cow dung) recorded maximum collar girth which was followed by T_6 (soil : sand : 1 month decomposed garbage), T_4 (soil : sand : fresh garbage), T_2 (soil : sand), T_5 (soil : sand : 2 week decomposed garbage) and T_1 (soil alone). Treatment T_1 (soil alone) showed minimum collar girth of 3.42 mm. At the end of the study period, two treatments T_2 (soil : sand) and T_4 (soil : sand : fresh garbage) recorded uniform girth of 3.94 mm. Similarly the two treatments T_4 (soil : sand : fresh garbage) and T_5 (soil : sand : 2 week decomposed garbage) were found to be on par throughout the study period (Tables 5 and Fig. 4). With regard to the maximum increase in collar girth at the end of the study, the treatment T_3 (soil : sand : cow dung) was standing first with an increment of (3.62mm) and was very closely followed by the treatment T_6 (soil :

Table 5. Effect of potting media on collar girth (mm) of teak seedlings at fortnightly intervals

Treatment number	Treatment details	Fortnights											
		1	2	3	4	5	6	7	8	9	10	11	12
T_1	Soil alone	1.54	1.60	1.68	1.84	1.98	2.24	2.60	2.90	3.15	3.35	3.40	3.42
T_2	Soil : Sand (1:1)	1.60	1.70	1.82	1.90	2.13	2.38	2.71	3.06	3.15	3.27	3.67	3.94
T_3	Soil : Sand : Cow dung (1:1:1)	1.87	1.92	2.00	2.12	2.45	2.77	3.28	3.67	4.02	4.48	5.02	5.49
T_4	Soil : Sand : Fresh garbage (1:1:1)	1.37	1.50	1.71	1.83	1.97	2.20	2.57	2.82	3.05	3.32	3.63	3.94
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	1.58	1.69	1.78	1.84	2.04	2.26	2.59	2.86	3.01	3.16	3.40	3.72
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	1.68	1.79	1.97	2.03	2.40	2.68	3.20	3.59	3.92	4.30	4.74	5.21
	F test	NS	NS	**	**	**	**	**	**	**	**	**	**
	SEm±	0.06	0.05	0.06	0.07	0.10	0.12	0.14	0.13	0.19	0.18	0.17	0.20
	CD (0.05)	-	-	0.178	0.208	0.297	0.356	0.416	0.386	0.564	0.535	0.505	0.446

** Significant at 1 per cent level NS - Non significant

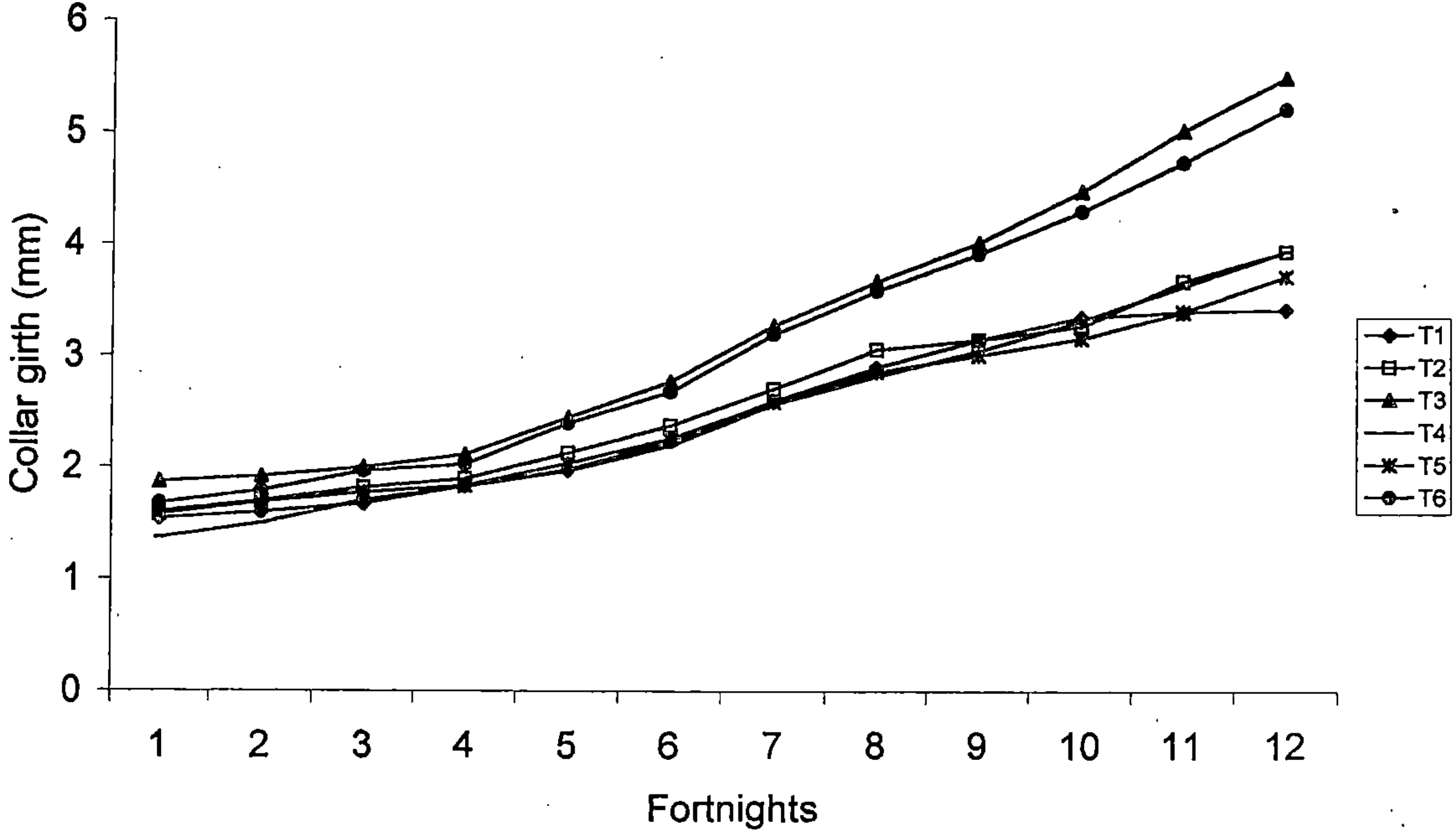

Fig. 4. Effect of potting media on collar girth of teak seedlings at fortnightly intervals

sand : 1 month decomposed garbage) with an increment of 3.53 mm. The least increment was recorded by treatment T_1 (soil alone) where it was only 2.08 mm.

The positive effect of potting media on the girth of seedlings of mangium at fortnightly intervals is evident from the data tabulated in Table 6. At the end of the study, maximum collar girth was recorded by the treatment T_3 (soil : sand : cow dung) which was followed by T_6 (soil : sand : 1 month decomposed garbage), T_2 (soil : sand), T_1 (soil alone) and T_4 (soil : sand : fresh garbage). The treatment T_5 (soil : sand : 2 week decomposed garbage) recorded minimum value (3.41 mm) with regard to collar girth (Table 6). Treatments T_1 (soil alone) and T_2 (soil : sand) were found to be on par during the first two fortnights. This was also true in the case of T_5 (soil : sand : two week decomposed garbage) and T_6 (soil : sand : 1 month decomposed garbage). Similarly from the fourth fortnight onwards, the treatments T_4 (soil : sand : fresh garbage) and T_5 (soil : sand : 2 week decomposed garbage) were found to be on par with regard to girth. One interesting observation about the girth is that even though the treatment T_3 (soil : sand : cow dung) recorded maximum girth of 5.31 mm at the end of the study period, maximum girth increment of 3.64 mm was recorded by the treatment T_6 (soil : sand : 1 month decomposed garbage). It could also be seen from the table that in the case of treatment T_3 (soil : sand : cow dung), girth increment at the end of the study was only 3.57 mm. Effect of potting media on collar girth of mangium is also depicted in Figure 5.

Table 6. Effect of potting media on collar girth (mm) of mangium seedlings at fortnightly intervals

Treatment number	Treatment details	Fortnights											
		1	2	3	4	5	6	7	8	9	10	11	12
T_1	Soil alone	1.25	1.29	1.38	1.52	1.65	1.90	2.16	2.55	2.86	3.21	3.62	3.94
T_2	Soil : Sand (1:1)	1.28	1.32	1.59	1.71	2.02	2.31	2.67	3.01	3.29	3.61	4.02	4.70
T_3	Soil : Sand : Cow dung (1:1:1)	1.74	1.96	2.20	2.52	3.07	3.37	3.59	3.96	4.27	4.38	4.80	5.31
T_4	Soil : Sand : Fresh garbage (1:1:1)	1.18	1.22	1.42	1.58	1.92	2.12	2.28	2.42	2.87	3.20	3.33	3.52
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	1.47	1.53	1.69	1.80	1.89	2.02	2.14	2.47	2.68	2.97	3.20	3.41
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	1.48	1.57	1.82	2.26	2.66	3.22	3.48	3.69	4.02	4.14	4.69	5.12
	F test	**	**	*	*	**	**	**	**	**	**	**	**
	SEm±	0.05	0.06	0.06	0.08	0.10	0.11	0.14	0.15	0.18	0.18	0.18	0.22
	CD (0.05)	0.149	0.152	0.178	0.238	0.297	0.327	0.332	0.386	0.446	0.535	0.535	0.548

** Significant at 1 per cent level   * Significant at 5 per cent level

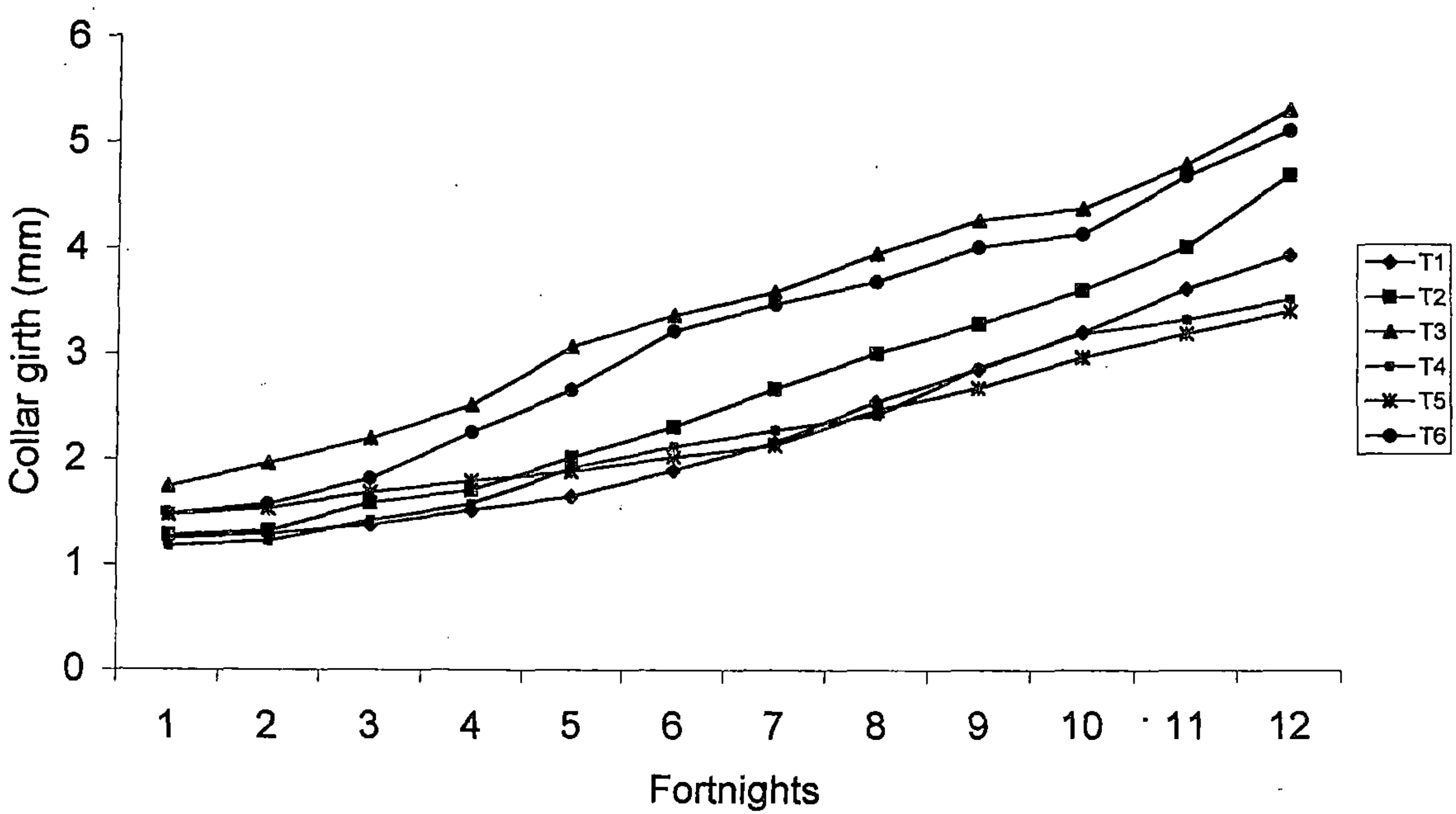

Fig. 5. Effect of potting media on collar girth of mangium seedlings at fortnightly intervals

4.2.3 Leaf area

There exists significant difference between the treatments with regard to leaf area in teak (Table 7). At the end of the study period, maximum leaf area of 715.03 cm^2 was recorded by the treatment T_3 (soil : sand : cow dung) followed by T_6 (soil : sand : 1 month decomposed garbage - 596.83 cm^2), T_5 (soil : sand : 2 week decomposed garbage - 391.88 cm^2), T_4 (soil : sand : fresh garbage - 291.96 cm^2) and T_1 (soil alone - 207.01 cm^2). Minimum leaf area of 193.90 cm^2 was recorded by the treatment T_2 (soil : sand) and this was found to be on par with T_1 (soil alone). All the treatments except T_1 (soil alone) and T_2 (soil : sand) showed a decrease in leaf area after the fourth month of study. All the other treatments recorded maximum leaf area during the fourth month of study. Treatments T_5 (soil : sand : 2 week decomposed garbage) was found to be on par with T_6 (soil : sand : 1 month decomposed garbage) during the first two months of observation. The decrease in leaf area from the fourth month onwards was more pronounced in seedlings planted in potting media containing soil, sand and cow dung in equal proportions. Here a reduction of leaf area to the tune of 42 per cent occurred within two months. The respective reductions were to the tune of 31.6 per cent in the case of T_6 (soil : sand : 1 month decomposed garbage), 38.02 per cent in the case of T_5 (soil : sand : 2 week decomposed garbage) and 25 per cent in the case of T_4 (soil : sand : fresh garbage).

Data furnished in Table 8 indicate the significant effect of treatments on leaf area of seedlings of mangium. At the end of the study i.e., after the six month,

Table 7. Effect of potting media on leaf area (cm^2) of teak seedlings

Treat-ment Number	Treatment details	Months					
		1	2	3	4	5	6
T_1	Soil alone	42.05	75.80	106.23	144.54	197.40	207.01
T_2	Soil : Sand (1:1)	33.70	53.80	89.58	127.33	171.35	193.90
T_3	Soil : Sand : Cow dung (1:1:1)	191.35	333.78	681.45	1237.68	1132.28	715.03
T_4	Soil : Sand : Fresh garbage (1:1:1)	73.93	139.16	238.18	390.75	361.25	291.96
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	104.35	201.18	347.75	632.28	476.18	391.88
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	118.13	229.50	554.23	873.63	664.23	596.83
	F test	**	**	**	**	**	**
	SEm±	5.26	9.99	23.19	18.73	23.12	22.57
	CD(0.05)	15.622	29.670	68.874	55.628	68.666	67.033

** Significant at 1 per cent level

Table 8. Effect of potting media on leaf area (cm^2) of mangium seedlings

Treatment number	Treatment details	Months					
		1	2	3	4	5	6
T_1	Soil alone	30.68	54.85	77.66	128.04	267.03	344.48
T_2	Soil : Sand (1:1)	53.58	122.68	228.80	382.25	529.84	667.48
T_3	Soil : Sand : Cow dung (1:1:1)	128.50	232.58	436.10	653.58	994.73	1095.45
T_4	Soil : Sand : Fresh garbage (1:1:1)	38.23	51.70	98.65	197.03	349.18	453.88
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	65.78	136.13	224.38	411.48	675.40	795.93
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	97.80	195.18	332.58	666.40	1036.48	1142.20
	F test	**	**	**	**	**	**
	SEm±	4.73	8.96	20.21	35.71	31.87	40.91
	CD(0.05)	14.048	26.611	60.024	106.059	94.654	121.503

** Significant at 1 per cent level

the treatment T_6 (soil : sand : 1 month decomposed garbage) recorded maximum leaf area of 1142.20 cm^2 and was followed by T_3 (soil : sand : cow dung - 1095.45 cm^2), T_5 (soil : sand : 2 week decomposed garbage - 795.93 cm^2), T_2 (soil : sand - 667.48 cm^2) and T_4 (soil : sand : fresh garbage - 453.88 cm^2). The treatment T_1 (soil alone) recorded the lowest leaf area of 344.48 cm^2. From the fourth month onwards, the treatment T_6 (soil : sand : 1 month decomposed garbage) was found to be on par with T_3 (soil : sand : cow dung). Till the end of third month of study, the treatment T_3 (soil : sand : cow dung) was performing better compared to T_6 (soil : sand : 1 month decomposed garbage). But from the fourth month onwards treatment T_6 performed better. Interestingly the treatments showed an increasing trend with regard to leaf area throughout the period of study. The effect of potting media on leaf area of teak and mangium seedlings is also depicted in Figures 6 and 7 respectively.

4.2.4 Shoot fresh and dry weight

The data furnished in Table 9 indicate that in teak, there exist significant differences between treatments with regard to shoot fresh and dry weights. The treatment T_3 (soil : sand : cow dung) recorded maximum fresh weight of seedlings throughout the period of study. At the end of the sixth month, the treatment T_3 (soil : sand : cow dung) recorded maximum fresh weight of 15.02 g and was closely followed by the treatment T_6 (soil : sand : 1 month decomposed garbage) where it was 14.89 g. The treatment T_1 (soil alone) recorded minimum fresh weight of 5.44 g. It could also be seen from the table that the treatments T_1 (soil alone) and

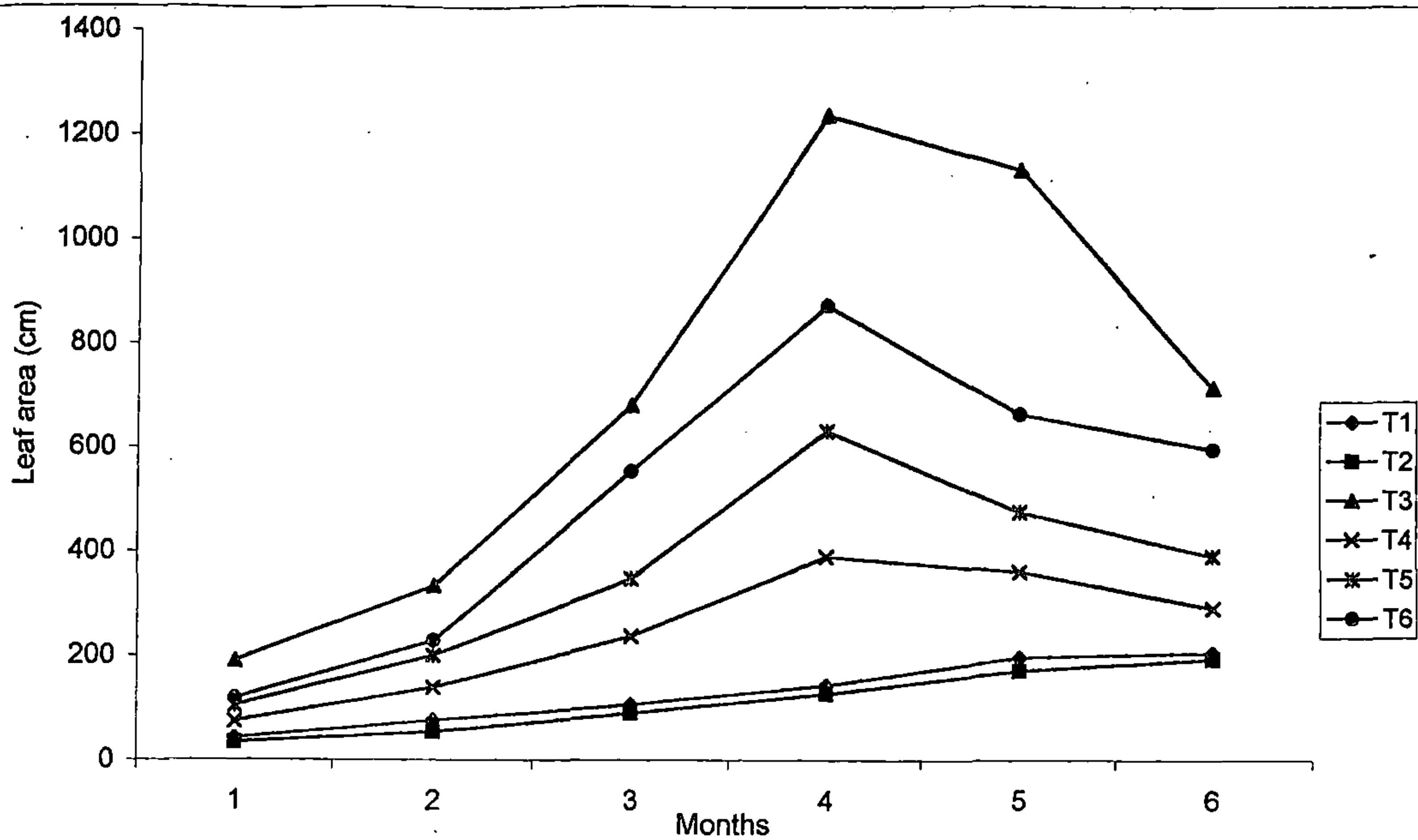

Fig . 6. Effect of potting media on leaf area of teak seedlings at monthly intervals

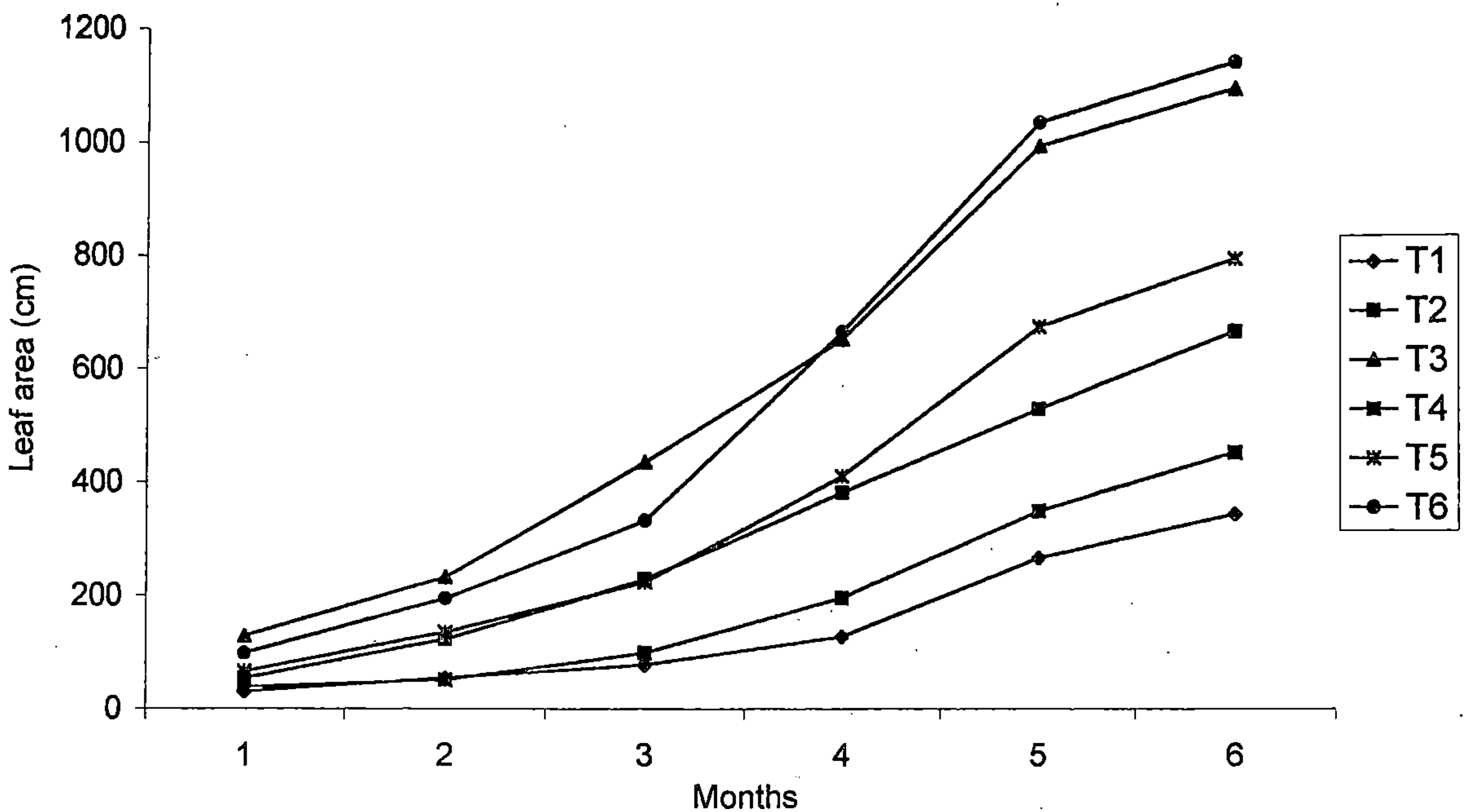

Fig. 7. Effect of potting media on leaf area of mangium seedlings at monthly intervals

Table 9. Effect of potting media on fresh and dry weight (g) of shoots of teak seedlings

Treatment number	Treatment details	Months											
		1		2		3		4		5		6	
		Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	Soil alone	0.69	0.12	1.39	0.32	2.20	0.80	2.84	0.92	4.22	1.22	5.44	1.58
T_2	Soil : Sand (1:1)	1.18	0.29	2.41	0.67	3.53	0.99	4.08	1.20	5.80	1.76	6.09	2.12
T_3	Soil : Sand : Cow dung (1:1:1)	2.90	0.79	4.58	1.48	6.92	2.22	12.01	3.66	13.97	4.46	15.02	4.82
T_4	Soil : Sand : Fresh garbage (1:1:1)	1.00	0.26	2.30	0.73	3.39	1.03	4.87	1.46	6.49	2.13	8.56	2.67
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	1.94	0.45	2.98	0.87	4.86	1.51	8.57	2.61	10.92	3.39	11.20	4.27
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	2.17	0.61	2.82	0.84	4.99	1.65	9.20	2.77	12.75	3.59	14.89	4.28
	F test	**	**	**	**	**	**	**	**	**	**	**	**
	SEm±	0.32	0.10	0.50	0.17	0.55	0.18	0.69	0.21	0.66	0.24	0.85	0.27
	CD(0.05)	0.950	0.297	1.485	0.505	1.634	0.535	2.049	0.624	1.960	0.713	2.225	0.802

** Significant at 1 per cent level

T_2 (soil : sand) were found to be on par throughout the study period. In the case of treatment T_3 (soil : sand : cow dung), an increase of fresh weight to the tune of 73 per cent was noticed between the third and fourth month of the study.

With regard to dry weight in teak, the treatment T_3 (soil :sand :cow dung) recorded the maximum dry weight of 4.82 g at the end of the study period. This trend could be seen from the beginning of the study itself (Table 9). The observations of sixth month revealed that the treatment T_3 (soil :sand :cow dung) was closely followed by T_6 (soil : sand : 1 month decomposed garbage - 4.28 g) and T_5 (soil : sand : 2 week decomposed garbage - 4.27 g). The lowest dry weight of 1.58 g was recorded by the treatment T_1 (soil alone). The treatment T_3 (soil : sand : cow dung) which recorded maximum dry weight at the end of the study showed maximum increment between the third and fourth month of growth.

In the case of mangium also, at the end of the sixth month, the treatment T_3 (soil : sand : cow dung) recorded maximum shoot fresh weight (18.50 g) and was followed by treatments T_6 (soil : sand : 1 month decomposed garbage - 17.45 g), T_5 (soil : sand : 2 week decomposed garbage - 10.07 g), T_2 (soil : sand - 6.94 g), T_4 (soil : sand : fresh garbage - 4.60 g) and T_1 (soil alone - 4.4 g) as is revealed by the data furnished in Table 10. The treatments T_3 (soil : sand : cow dung) and T_6 (soil : sand : 1 month decomposed garbage) were found to be on par throughout the period of study. Similar is the case with the treatments T_1 (soil alone) and T_4 (soil : sand : fresh garbage).

Table 10. Effect of potting media on fresh and dry weight (g) of shoots of mangium seedlings

Treatment number.	Treatment details	Months											
		1		2		3		4		5		6	
		Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	Soil alone	0.48	0.10	0.86	0.22	1.88	0.49	2.71	0.79	3.43	1.02	4.41	1.37
T_2	Soil : Sand (1:1)	0.74	0.19	1.53	0.43	2.51	0.71	3.72	1.09	5.14	1.58	6.94	2.09
T_3	Soil : Sand : Cow dung (1:1:1)	1.46	0.45	3.75	1.10	6.85	2.08	11.38	3.61	15.72	4.87	18.50	5.65
T_4	Soil : Sand : Fresh garbage (1:1:1)	0.44	0.12	0.97	0.29	2.16	0.57	2.99	0.92	4.46	1.43	4.60	1.45
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	0.87	0.17	1.82	0.49	3.22	0.98	4.58	1.40	8.63	2.60	10.07	3.01
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	1.02	0.30	2.80	0.85	5.98	1.55	10.00	2.84	14.76	4.56	17.45	5.44
	F test	**	*	**	**	**	**	**	**	*	**	*	*
	SEm±	0.11	0.05	0.30	0.10	0.36	0.12	0.61	0.24	0.73	0.25	0.98	0.29
	CD(0.05)	0.327	0.149	0.891	0.297	1.069	0.356	1.812	0.713	2.168	0.743	2.911	0.861

** Significant at 1 per cent level   * Significant at 5 per cent level

The treatments did exert significant influence on the shoot dry weight of mangium also. Seedlings grown in potting media containing equal parts of soil, sand and cow dung recorded maximum shoot dry weight of 5.65 g at the end of sixth month and this was immediately followed by T_6 (soil : sand : 1 month decomposed garbage - 5.44 g). The treatment T_1 (soil alone - 1.37 g) recorded the lowest value for dry weight at the end of the study period. Seedlings raised in the treatment T_3 (soil : sand : cow dung) showed maximum increment in dry weight from initial (0.45 g) during the first month to the final (5.65 g) at the end of the sixth month of the study period.

4.3 Effect of potting media on root growth parameters

Observations on various root growth characters viz., length, number, spread and fresh and dry weights of roots of the two species of teak and mangium as influenced by various potting media are given in Tables 11 to 14.

4.3.1 Root Length

In teak, the treatments did not manifest any significant effect on root length as is evident from the data furnished in Table 11. However, the treatment T_6 (soil : sand : 1 month decomposed garbage) recorded maximum root length (29.10 cm) and was followed by T_4 (soil : sand : fresh garbage), T_5 (soil : sand : 2 week decomposed garbage), T_1 (soil alone), T_3 (soil : sand : cow dung) and T_2 (soil : sand). In all the treatments maximum root length occurred in the second half of the study period commencing from third month onwards.

Table 11. Effect of potting media on root growth parameters of teak seedlings

Treatment number	Treatment details	Root length (cm)						Root number						Root spread (cm)					
		Months						Months						Months					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1	Soil alone	12.03	16.60	17.80	20.65	23.63	25.38	5.75	9.50	10.00	16.75	24.50	18.50	3.68	5.28	8.00	8.43	8.55	9.28
T_2	Soil : Sand (1:1)	9.50	11.25	14.98	18.35	21.00	21.70	6.25	9.00	10.75	14.75	20.50	17.25	5.38	8.43	8.90	10.83	9.05	11.85
T_3	Soil : Sand : Cow dung (1:1:1)	11.43	13.38	16.73	20.33	24.33	24.55	4.75	12.25	16.00	19.25	18.25	24.50	7.80	7.45	9.68	8.08	11.35	10.18
T_4	Soil : Sand : Fresh garbage (1:1:1)	11.68	14.70	17.98	21.95	25.05	26.33	9.50	12.25	15.25	19.75	17.25	22.00	8.20	8.03	10.73	10.08	8.95	13.08
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	12.40	14.43	16.05	20.43	24.41	25.88	7.50	11.75	14.75	16.12	15.00	27.10	9.48	8.83	11.03	11.50	14.35	15.40
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	14.03	15.83	19.05	22.60	25.55	29.10	10.00	12.50	13.25	19.25	22.50	30.63	9.90	10.40	12.15	10.20	14.58	12.98
	F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	SEm±	1.69	1.52	1.55	1.99	2.54	2.66	1.36	1.76	2.35	2.08	3.04	3.65	1.52	1.28	1.47	2.11	2.01	2.15
	CD(0.05)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NS - Non significant

In mangium also no significant effect of treatments with regard to root length was observed. However, the treatment T_3 (soil : sand : cow dung) tended to produce more root length (31.5 cm), which was immediately followed by the treatment T_6 (soil : sand : 1 month decomposed garbage) which recorded a root length of 29.08 cm. The minimum root length was recorded by seedlings raised in the potting medium containing soil and sand in 1 : 1 ratio. Though the treatment T_3 (soil : sand : cow dung) was on par with other treatments initially, from the third month onwards it showed a better trend compared to other treatments. The effect of potting media on root length of teak and mangium is also depicted in Plates 7 and 8 respectively.

4.3.2 Root number

In both teak and mangium, the treatment did not exert any significant effect on the number of roots produced per seedling. All the six treatments were found to be on par. However, the treatment T_6 (soil : sand : 1 month decomposed garbage) recorded slightly more number of roots in teak during almost all stages of growth. This was immediately followed by the treatment T_4 (soil : sand : fresh garbage). The treatment T_2 (soil : sand) recorded less number of roots.

In the case of mangium , the treatment T_5 (soil : sand : 2 week decomposed garbage) produced slightly more number of roots at the end of the study period, though it was not statistically significant compared to the other treatments (Table 12). Like teak, here also the treatment T_2 (soil : sand) tended to produce minimum number of roots (15.00) at the end of the study period.

Table 12. Effect of potting media on root growth parameters of mangium seedlings

Treatment number.	Treatment details	Root length (cm)						Root number						Root spread (cm)					
		Months						Months						Months					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1	Soil alone	5.32	6.91	13.05	18.93	20.03	27.34	7.73	11.00	14.50	14.75	18.25	17.25	7.53	10.03	11.45	12.23	15.33	17.06
T_2	Soil : Sand (1:1)	6.51	6.84	12.11	16.33	18.95	25.30	11.00	10.00	12.75	15.50	15.25	15.00	7.58	11.90	11.35	19.43	17.15	15.45
T_3	Soil : Sand : Cow dung (1:1:1)	5.56	7.19	18.40	22.15	25.95	31.50	9.75	11.50	16.50	16.00	19.75	20.25	11.95	12.85	16.13	14.43	15.75	22.18
T_4	Soil : Sand : Fresh garbage (1:1:1)	3.70	5.73	11.81	16.03	20.60	22.08	8.00	11.25	14.00	17.25	19.75	22.25	5.38	8.60	10.33	13.43	21.35	21.50
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	4.47	6.53	12.31	20.13	20.75	24.90	9.00	9.00	11.25	17.25	18.50	24.25	6.83	8.33	13.43	17.40	19.03	19.38
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	6.50	10.73	14.83	20.10	24.20	29.08	11.75	13.00	15.25	18.75	24.50	18.75	7.38	9.98	18.30	18.38	22.28	21.73
	F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	SEm±	1.28	1.34	2.44	3.07	4.78	5.80	1.68	1.91	1.45	3.15	3.41	3.56	1.78	2.10	2.58	2.78	3.35	3.77
	CD(0.05)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NS - Non significant

Plate 7. Variation in root length of teak seedlings at the end of the study as influenced by different potting media

T_1 - Soil alone

T_2 - Soil:sand (1:1 ratio)

T_3 - Soil:sand:cow dung (1:1:1 ratio)

T_4 - Soil:sand:fresh garbage (1:1:1 ratio)

T_5 - Soil:sand:two week decomposed garbage (1:1:1 ratio)

T_6 - Soil:sand:one month decomposed garbage (1:1:1 ratio)

Plate 8. Variation in root length of mangium seedlings at the end of the study as influenced by different potting media

T_1 - Soil alone

T_2 - Soil:sand (1:1 ratio)

T_3 - Soil:sand:cow dung (1:1:1 ratio)

T_4 - Soil:sand:fresh garbage (1:1:1 ratio)

T_5 - Soil:sand:two week decomposed garbage (1:1:1 ratio)

T_6 - Soil:sand:one month decomposed garbage (1:1:1 ratio)


T1
T2
T3
T4
T5
T6


T1
T2
T3
T4
T5
T6

4.3.3 Root spread

In both teak and mangium, the treatments did not show any significant effect with regard to root spread (Tables 11 and 12). However, a close perusal of the data showed that in teak the treatments T_5 (soil : sand : 2 week decomposed garbage) and T_1 (soil alone) recorded the higher and lower values respectively with regard to root spread, while in mangium the treatments T_6 (soil : sand : 1 month decomposed garbage) and T_4 (soil : sand : fresh garbage) recorded the higher and lower values with regard to root spread.

4.3.4 Root fresh and dry weight

The data furnished in Table 13 reveal that in teak, the treatments exerted significant influence on fresh weight of roots from the fifth month onwards. At the end of the sixth month of study, the treatment T_5 (soil : sand : 2 week decomposed garbage) recorded maximum root fresh weight of 10.74 g and the minimum fresh weight of 4.43 g was recorded by T_2 (soil : sand). It could be seen that as the study period progressed, the treatment T_3 (soil : sand : cow dung) showed a gradual increase in root fresh weight. Till the fifth month, this treatment showed a better performance compared to other treatments. But during the sixth month the increment in fresh weight was found to be slightly reduced and was much lower compared to the previous month.

With regard to the dry weight of roots, the treatments exerted significant influence from the fifth month of study onwards. The treatment T_5 (soil : sand : 2 week decomposed garbage) recorded maximum root dry weight of 3.12 g at the

Table 13. Effect of potting media on fresh and dry weight (g) of roots of teak seedlings

Treatment number	Treatment details	Months											
		1		2		3		4		5		6	
		Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	Soil	1.01	0.31	1.56	0.47	3.40	1.08	4.41	1.39	5.68	1.82	5.78	1.88
T_2	Soil : Sand (1:1)	0.92	0.29	1.75	0.53	2.80	0.87	3.17	1.02	3.29	1.06	4.43	1.41
T_3	Soil : Sand : Cow dung (1:1:1)	2.07	0.59	3.45	1.10	4.92	1.61	6.39	2.04	8.25	2.74	9.25	3.04
T_4	Soil : Sand : Fresh garbage (1:1:1)	1.50	0.51	2.43	0.74	3.44	1.14	5.42	1.72	6.48	2.04	10.02	3.11
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	1.80	0.54	2.39	0.72	3.26	1.19	5.33	1.76	6.77	1.96	10.74	3.12
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	1.70	0.51	2.32	0.96	3.24	1.10	5.16	1.87	8.04	2.12	10.21	3.02
	F test	NS	NS	NS	NS	NS	NS	NS	NS	**	**	**	**
	SEm±	0.21	0.07	0.33	0.19	0.35	0.11	0.78	0.24	0.85	0.27	1.23	0.58
	CD(0.05)	-	-	-	-	-	-	-	-	2.525	0.802	3.253	1.723

** Significant at 1 per cent level NS - Non significant end of the sixth month of study and was closely followed by T_4 (soil : sand : fresh garbage - 3.11 g). The lowest root dry weight at the end of the study was recorded by T_2 (soil : sand - 1.41 g).

In mangium also the treatments exerted significant influence on fresh weight of roots (Table 14). The treatment T_3 (soil : sand : cow dung) recorded maximum fresh weight of 4.08 g at the end of the sixth month of the study. This was followed by treatments, T_4 (soil : sand : fresh garbage - 3.01 g) ,T_5 (soil : sand : 2 week decomposed garbage - 2.57 g), T_1 (soil alone - 2.38 g), T_6 (soil : sand : 1 month decomposed garbage - 2.19 g) and T_2 (soil : sand - 1.83 g).

The treatment T_3 (soil : sand : cow dung) recorded maximum root dry weight of 1.29 g at the end of the study period in mangium. The lowest value was recorded by T_2 (soil : sand - 0.51 g). Except during the third month of study, the treatments T_5 and T_6 were found to be on par with each other. The treatment T_6 (soil : sand : 1 month decomposed garbage) did not show any increase in dry weight between the first and the second month of the study period.

4.4 Effect of potting media on chlorophyll content of seedlings

Chlorophyll 'a', chlorophyll 'b' and total chlorophyll content of seedlings of teak and mangium as influenced by different potting media are tabulated in Tables 15 and 16 respectively.

Table 14. Effect of potting media on fresh and dry weight (g) of roots of mangium seedlings

Treatment number	Treatment details	Months											
		1		2		3		4		5		6	
		Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	Soil alone	0.20	0.05	0.49	0.13	0.79	0.19	1.01	0.24	1.80	0.53	2.38	0.65
T_2	Soil : Sand (1:1)	0.12	0.03	0.25	0.07	0.56	0.14	0.86	0.23	1.03	0.27	1.83	0.51
T_3	Soil : Sand : Cow dung (1:1:1)	0.66	0.22	1.09	0.33	2.13	0.63	3.10	0.91	3.07	0.93	4.08	1.29
T_4	Soil : Sand : Fresh garbage (1:1:1)	0.15	0.04	0.45	0.13	0.89	0.29	1.32	0.38	2.15	0.59	3.01	0.86
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	0.21	0.06	0.27	0.09	0.64	0.20	1.16	0.33	1.99	0.55	2.57	0.74
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	0.22	0.05	0.21	0.05	0.68	0.19	0.98	0.26	1.76	0.46	2.19	0.85
	F test	**	**	*	*	**	**	*	**	**	**	**	*
	SEm±	0.06	0.02	0.07	0.02	0.12	0.04	0.14	0.05	0.24	0.08	0.31	0.10
	CD(0.05)	0.18	0.059	0.21	0.059	0.36	0.119	0.416	0.149	0.713	0.238	0.921	0.297

** Significant at 1 per cent level   * Significant at 5 per cent level

Table 15. Effect of potting media on chlorophyll content (mg g^{-1}) of teak seedlings

Treatment number	Treatment details	Months																	
		1			2			3			4			5			6		
		Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl
T_1	Soil alone	4.60	3.80	4.50	3.93	2.37	6.31	6.70	4.35	5.50	5.91	4.02	4.99	7.47	5.03	6.27	5.40	3.84	4.71
T_2	Soil : Sand (1:1)	3.74	2.74	3.33	5.40	3.89	4.80	4.90	3.60	4.40	7.76	5.11	6.40	4.20	3.50	3.80	5.74	3.50	4.49
T_3	Soil : Sand : Cow dung (1:1:1)	5.90	4.30	5.30	6.09	4.05	5.06	6.77	4.61	5.72	6.56	4.29	5.30	6.27	3.96	5.03	7.12	4.49	5.70
T_4	Soil : Sand : Fresh garbage (1:1:1)	4.93	2.90	3.79	3.09	4.32	4.58	5.50	3.20	4.16	4.92	3.02	3.94	5.34	3.34	4.23	4.93	5.40	5.98
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	5.51	3.21	4.18	4.70	3.60	4.40	4.32	2.64	3.38	6.79	4.35	5.50	7.12	4.49	5.70	4.80	5.50	3.20
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	5.40	3.84	4.71	6.44	4.14	5.22	5.74	3.50	4.49	6.20	4.12	5.01	7.13	4.79	5.96	7.16	5.80	6.92

Table 16. Effect of potting media on chlorophyll content (mg g^{-1}) of mangium seedlings

Treatment number	Treatment details	Months																	
		1			2			3			4			5			6		
		Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl	Chl 'a'	Chl 'b'	Total Chl
T_1	Soil alone	4.32	2.94	3.65	3.74	2.74	3.33	3.59	2.45	3.04	6.72	3.89	5.07	3.09	4.32	4.58	7.86	5.16	6.47
T_2	Soil : Sand (1:1)	3.55	2.47	3.05	3.01	2.72	5.74	4.60	3.80	4.50	5.90	4.30	5.30	5.50	3.80	4.70	5.34	3.32	4.23
T_3	Soil : Sand : Cow dung (1:1:1)	5.40	3.84	4.71	5.35	6.05	6.66	6.44	4.14	5.22	4.90	3.60	4.40	4.93	5.40	5.98	6.77	4.61	5.72
T_4	Soil : Sand : Fresh garbage (1:1:1)	4.32	2.64	3.38	4.92	3.02	3.94	4.90	3.60	4.40	6.56	4.19	5.30	6.27	3.98	5.04	6.47	4.21	5.29
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	4.92	3.02	3.94	6.46	4.50	5.56	5.80	3.54	4.54	5.50	3.20	4.16	7.13	4.79	5.96	4.88	3.09	3.92
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	4.76	2.28	3.17	4.90	3.60	4.40	7.86	5.16	6.47	5.34	3.32	4.23	4.20	3.50	3.80	5.40	4.50	5.30

4.4.1 Chlorophyll 'a'

In both teak and mangium, no uniform trend could be seen on the effect of treatments on chlorophyll content. A close perusal of the data with regard to teak reveal that the treatment T_3 (soil : sand : cow dung) recorded a high content of chlorophyll 'a' when compared to other treatments. At the end of the study period, T_3 (soil : sand : cow dung) registered a concentration of 5.70 mg g^{-1}.

All treatments except T_4 and T_5 showed an increase in the chlorophyll 'a' content at the end of the sixth month of study. In treatment T_1 (soil alone) chlorophyll 'a' content increased from 4.60 mg g^{-1} to 5.40 mg g^{-1} while the increase in T_2 (soil : sand), T_3 (soil : sand : cow dung) and T_6 (soil : sand : 1 month decomposed garbage) were from 3.74 to 5.74 mg g^{-1}, 5.90 to 7.12 mg g^{-1} and 5.40 to 7.16 mg g^{-1} respectively. The treatment T_4 (soil : sand : fresh garbage) showed no change from the initial content of 4.93 mg g^{-1}. However in T_5 (soil : sand : 2 week decomposed garbage) the chlorophyll 'a' content reduced from the initial content of 5.51 mg g^{-1} to 4.80 mg g^{-1} towards the end of the study.

In mangium also the treatment T_3 (soil : sand : cow dung) performed better with regard to chlorophyll 'a' content. At the end of the study period, T_3 (soil : sand : cow dung) recorded a concentration of 6.77 mg g^{-1}. All the treatments except T_5 (soil : sand : 2 week decomposed garbage) showed an increase in chlorophyll content at the end of the study period. In treatment T_5 (soil : sand : 2 week decomposed garbage, there was a gradual decrease in the chlorophyll content compared to the initial value.

4.4.2 Chlorophyll 'b'

In teak, a perusal of data between the first and the last month of study period reveal that all treatments registered an increase in chlorophyll 'b' content. This increase was more pronounced in seedlings grown in treatment T_2 (soil : sand) where an increase from 2.90 mg g^{-1} to 5.40 mg g^{-1} was noticed. A similar trend was noticed in T_5 (soil : sand : 2 week decomposed garbage) also. The treatment T_1 (soil alone) registered the lowest increment from 3.80 to 3.84 mg g^{-1}. The treatment T_5 (soil : sand : 2 week decomposed garbage) registered maximum content of chlorophyll 'b' (5.50 mg g^{-1}) at the end of the sixth month of the study period. The treatment T_2 (soil : sand) recorded the minimum concentration of chlorophyll 'b' (2.74 mg g^{-1}) during the first month of the study period.

In the case of mangium, all treatments registered an increase in chlorophyll 'b' content during the course of the study period. The treatment T_3 (soil : sand : cow dung) showed better performance by registering a chlorophyll 'b' content of 4.61 mg g^{-1} at the end of the study period whereas T_2 (soil : sand) recorded the lowest content of 3.32 mg g^{-1}. In general, the lowest concentration of chlorophyll during the entire period of study was recorded by the seedlings grown in the treatment T_6 (soil : sand : 1 month decomposed garbage).

4.4.3 Total chlorophyll

In teak, when the total chlorophyll content of seedlings between the first and sixth month of study was compared, it was evident that all the treatments except T_5 (soil : sand : 2 week decomposed garbage) registered an increase in the concentration. In T_5, there was a decrease from 4.18 mg g^{-1} to 3.20 mg g^{-1}. The increase in total chlorophyll content was more pronounced in T_4 (soil : sand : fresh garbage) and T_6 (soil : sand : 1 month decomposed garbage) where an increase from 3.79 to 5.98 mg g^{-1} and 4.71 to 6.92 mg g^{-1} occurred respectively.

In mangium, a close perusal of data furnished in Table 16 reveal that the treatment T_3 (soil : sand : cow dung) was performing better than other treatments with regard to total chlorophyll content. Even though treatment T_1 (soil alone) registered a chlorophyll content of 6.47 mg g^{-1} during the sixth month, the relative content was much lower during the preceding months compared to T_3 (soil : sand : cow dung). All the treatments except T_5 (soil : sand : 2 week decomposed garbage) recorded a gradual increase in total chlorophyll content during the course of investigation.

4.5 Effect of potting media on nutrient content of seedlings

The results of chemical analysis in relation to nutrient content of teak and mangium seedlings grown in various potting media are tabulated in Tables 17 and 18 respectively.

4.5.1 Nitrogen

The treatments did exert significant influence on nitrogen content of both teak and mangium seedlings. Teak seedlings grown in treatment T_3 (soil : sand : cow dung) recorded maximum concentration of nitrogen throughout the study period, i.e., from the first to the sixth month of study. Treatment T_3 (soil :

Table 17. Effect of potting media on nutrient content of teak seedlings

Treatment number.	Treatment details	N %						P %						K %					
		Months						Months						Months					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1	Soil alone	1.00	1.18	1.57	1.94	2.22	2.74	0.11	0.13	0.16	0.19	0.21	0.23	0.44	0.46	0.53	0.66	0.87	1.17
T_2	Soil : Sand (1:1)	0.99	1.13	1.85	1.90	2.35	2.80	0.09	0.15	0.17	0.19	0.20	0.23	0.35	0.39	0.51	0.61	0.80	1.14
T_3	Soil : Sand : Cow dung (1:1:1)	1.42	1.87	2.44	3.06	3.15	3.37	0.19	0.20	0.21	0.22	0.24	0.28	0.51	0.57	0.69	0.82	0.98	1.11
T_4	Soil : Sand : Fresh garbage (1:1:1)	0.74	0.94	1.08	1.23	1.55	1.86	0.10	0.11	0.12	0.15	0.13	0.16	0.30	0.38	0.44	0.51	0.61	0.69
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	0.85	1.06	1.18	1.36	1.78	2.15	0.08	0.13	0.14	0.16	0.18	0.19	0.36	0.41	0.48	0.58	0.70	0.82
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	1.22	1.33	1.68	2.05	2.23	2.58	0.16	0.16	0.17	0.19	0.21	0.23	0.34	0.45	0.55	0.64	0.71	0.91
	F test	*	**	**	**	**	**	*	**	*	NS	**	**	*	NS	NS	*	**	**
	SEm±	0.14	0.15	0.16	0.14	0.12	0.14	0.02	0.01	0.02	0.02	0.02	0.02	0.04	0.06	0.06	0.06	0.05	0.04
	CD(0.05)	0.416	0.446	0.475	0.416	0.356	0.416	0.059	0.030	0.059	-	0.059	0.059	0.119	-	-	0.178	0.149	0.119

** Significant at 1 per cent level * Significant at 5 per cent level NS - Non significant

Table 18. Effect of potting media on nutrient content of mangium seedlings

Treat-ment number	Treatment details	N%						P%						K%					
		Months						Months						Months					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1	Soil alone	1.87	2.59	3.07	3.29	3.73	3.84	0.21	0.24	0.27	0.29	0.33	0.36	0.57	0.61	0.63	0.66	0.67	0.69
T_2	Soil : Sand (1:1)	1.88	2.56	2.82	3.20	3.49	3.92	0.29	0.29	0.30	0.35	0.36	0.39	0.49	0.52	0.54	0.57	0.57	0.63
T_3	Soil : Sand : Cow dung (1:1:1)	2.81	3.05	3.78	4.04	4.13	4.25	0.25	0.31	0.34	0.34	0.39	0.42	0.61	0.63	0.64	0.66	0.68	0.70
T_4	Soil : Sand : Fresh garbage (1:1:1)	1.41	1.78	2.02	2.78	2.95	3.21	0.20	0.24	0.26	0.28	0.27	0.31	0.28	0.29	0.31	0.33	0.35	0.37
T_5	Soil : Sand : 2 week decomposed garbage (1:1:1)	1.97	2.56	2.80	2.98	3.77	3.82	0.23	0.26	0.30	0.31	0.36	0.38	0.29	0.31	0.32	0.35	0.36	0.40
T_6	Soil : Sand : 1 month decomposed garbage (1:1:1)	2.13	2.84	3.06	3.43	3.88	3.98	0.28	0.29	0.31	0.32	0.34	0.39	0.30	0.33	0.36	0.40	0.42	0.48
	F test	**	**	**	*	**	**	**	*	**	**	**	**	**	**	**	**	**	**
	SEm±	0.15	0.14	0.11	0.14	0.11	0.12	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	CD(0.05)	0.446	0.416	0.327	0.416	0.327	0.356	0.059	0.030	0.030	0.030	0.059	0.059	0.030	0.030	0.030	0.030	0.030	0.030

** Significant at 1 per cent level * Significant at 5 per cent level

sand : cow dung) registered a nitrogen content of 3.37 per cent at the end of study followed by T_2 (soil : sand - 2.80%), T_1 (soil alone - 2.74 %), T_6 (soil : sand : 1 month decomposed garbage - 2.58%), T_5 (soil : sand : 2 week decomposed garbage - 2.15%) and T_4 (soil : sand : fresh garbage - 1.86 %). Maximum increment in the nitrogen content during the period of the study was recorded by T_3 (soil : sand : cow dung - 1.95 %) followed by T_2 (soil : sand - 1.81%), T_1 (soil alone - 1.74%), T_6 (soil : sand : 1 month decomposed garbage - 1.36%), T_5 (soil : sand : 2 week decomposed garbage - 1.30%) and T_4 (soil : sand : fresh garbage - 1.12%). Seedlings grown in treatments T_1 (soil alone), T_2 (soil : sand), T_4 (soil : sand : fresh garbage) and T_5 (soil : sand : 2 week decomposed garbage) are found to be on par with regard to nitrogen content throughout the study.

In the case of mangium, the treatment T_3 (soil : sand : cow dung) recorded maximum concentration of nitrogen throughout the study period. Here, the nitrogen concentration increased from an initial value of 2.81 per cent during the first month of study to 4.25 per cent at the end of sixth month. This was followed by T_6 (soil : sand : 1 month decomposed garbage) which registered an increase from 2.13 per cent to 3.98 per cent, T_5 (soil : sand : 2 week decomposed garbage) where the increase was from 1.97 to 3.82 per cent, T_2 (soil : sand) from 1.88 to 3.92 per cent, T_1 (soil alone) from 1.87 to 3.84 per cent and T_4 (soil : sand : fresh garbage) from 1.41 to 3.21 per cent. The treatments T_1 (soil alone) and T_2 (soil : sand) were on par throughout the study period (Table 18).

4.5.2 Phosphorous

In teak, except the fourth month, all the treatments showed significant effect on the phosphorous concentration of seedlings. Maximum concentration of phosphorous throughout the study period was recorded by seedlings grown in the treatment T_3 (soil : sand : cow dung). Seedlings of this treatment recorded a concentration of 0.28 per cent at the end of the study period. This was followed by T_2 (soil : sand - 0.23%), T_1 (soil alone - 0.23%), T_6 (soil : sand : 1 month decomposed garbage - 0.23%) and T_5 (soil : sand : 2 week decomposed garbage - 0.19%). The lowest concentration of 0.16 per cent of phosphorus was recorded by T_4 (soil : sand : fresh garbage). Eventhough the treatment T_3 (soil : sand : cow dung) registered maximum concentration of phosphorus (0.28%) at the end of study, the increment per cent from the initial value is only 47.30. But in the case of treatments T_2 (soil : sand) and T_1 (soil alone) , the increments are 155 and 109 per cent respectively.

Unlike teak, in the case of mangium, at the end of the sixth month of the study period, the treatment T_3 (soil : sand : cow dung) recorded maximum concentration of phosphorus (0.42%). This was followed by T_6 (soil : sand : 1 month decomposed garbage - 0.39%), T_2 (soil : sand - 0.39%) T_5 (soil : sand : 2 week decomposed garbage - 0.38%), T_1 (soil alone - 0.36%) and T_4 (soil : sand : fresh garbage - 0.31%). At the end of the study period, seedlings grown in treatments T_6 (soil : sand : 1 month decomposed garbage) and T_2 (soil : sand) recorded a uniform phosphorus content (0.39%). During the initial stage of study i.e., during the first month, the treatments T_2 (soil : sand) and T_6 (soil : sand : 1 month decomposed garbage) recorded high concentration of phosphorus (0.29 and 0.28% respectively). However, towards the end, T_3 (soil : sand : cow dung) recorded a high phosphorus value compared to other treatments. Similarly the treatment T_3 (soil : sand : cow dung) recorded maximum increment of 68 per cent in the concentration of phosphorus as the study progressed from the first to sixth month.

4.5.3 Potassium

In teak, no significant influence of treatments was observed during the second and third month of study with regard to the concentration of potassium. However, maximum concentration of potassium at the end of the study period was recorded by seedlings grown in treatment T_1 (soil alone - 1.17%) and was followed by T_2 (soil : sand - 1.14%), T_3 (soil : sand : cow dung - 1.11%), T_6 (soil : sand : 1 month decomposed garbage - 0.91%), T_5 (soil : sand : 2 week decomposed garbage - 0.82%) and T_4 (soil : sand : fresh garbage - 0.69%). Except for the fifth month, the treatments T_1 (soil alone) and T_2 (soil : sand) were found to be on par with regard to K concentration. Similarly T_5 (soil : sand : 2 week decomposed garbage) and T_6 (soil : sand : 1 month decomposed garbage) were also found to be on par almost during the entire course of the investigation. The treatment T_3 (soil : sand : cow dung) recorded maximum concentration of potassium till the end of the fifth month. Maximum increment in potassium concentration from the initial value at the first month to the final value at the end of sixth month was recorded by seedlings grown in treatment T_1 (soil alone).

Throughout the period of study, i.e., from the first to the sixth month, mangium seedlings raised by the treatment T_3 (soil : sand : cow dung) recorded maximum concentration of potassium. At the end of the sixth month of the study period, treatment T_3 (soil : sand : cow dung) recorded a potassium concentration of 0.70 per cent while the lowest concentration was recorded by T_4 (soil : sand : fresh garbage - 0.37%). The treatment T_3 (soil : sand : cow dung) was closely followed by T_1 (soil alone - 0.69%) and T_2 (soil : sand - 0.63%). Eventhough the treatment T_3 (soil : sand : cow dung) recorded maximum concentration of potassium at the end of the study, the increment from first to sixth month was greater in seedlings grown in the treatments T_1 (soil alone) and T_2 (soil : sand) .

DISCUSSION

DISCUSSION

While achieving the objectives of an optimal development and utilisation of new and renewable sources of energy, what should receive the prior attention of the scientists is the ways and means of recycling and utilisation of rural, urban and semi-urban wastes and agricultural residues. Most of the urban and rural wastes have high nutrient potential and can be used as a component of potting media. A large number of researches are going on in this regard on agricultural crops, particularly vegetables, but there seems to be no systematic work done on forest tree species. Hence, the present series of studies were taken up in the College of Forestry, Vellanikkara to ascertain the viability of using garbage as a component of potting media for raising good quality planting stocks of teak (*Tectona grandis* Linn F.) and mangium (*Acacia mangium* Willd.). These two species are very important for extensive planting under social and agroforestry programmes. The salient findings of the studies are discussed here under.

5.1 Effect of potting media on survival rate of seedlings

Garbage as a component of potting media did not result any substantial influence on survival rate of teak seedlings. But in the case of mangium, a high influence was noticed on the survival rate of seedlings. The effect on survival rate was more pronounced when fresh garbage was used as the component of potting media. When fresh garbage was used, mangium showed the lowest survival rate of 53 per cent whereas in the case of treatments T_5 (soil : Sand :2 Week decomposed garbage) and T_6 (soil : sand : 1 month decomposed garbage) a relatively high survival rate of 59 and 64 per cent was observed respectively. Thus the survival rate of mangium was found to be directly proportional to the period of decomposition of garbage. Wu-Weushi (1997) observed high rate of mortality and incidence of *Rhizoctona solani* and *Phytophthora capsici* attack on capsicum sp. when fresh garbage was used as a component of potting media. But when he used garbage decomposed for six months, the mortality was significantly reduced. Similar results were also observed in cowpea by Sarawanan and Baskar (1997). High mortality when fresh garbage was used as a component of potting media could be probably due to the low availability of nutrients in the media and also due to the infection of microorganisms present in the garbage. This can cause various types of diseases. Teak showed better performance than mangium due to its higher ability to withstand unfavourable conditions.

5.2 Effect of potting media on shoot growth parameters

The height, diameter and leaf area could be considered as important criteria for measuring vigour of seedlings as is reported by Hendromon (1988). In the present study, over all shoot growth performance of tree seedlings was influenced significantly by various types of potting media as is evident from the statistical analysis of the data. Similar results were also obtained by Tripathi and Bajpai (1984). They noticed that over all growth of *Anogeissus pendula* seedlings was much better in sand followed by red soil. El-Nour and El-Hassan (1987) recorded best growth of *Eucalyptus camaldulensis* seedlings in a pure silt medium with watering every two days.

In the present study, the seedlings of teak recorded maximum height of 42.9 cm in the medium containing soil, sand and cow dung in equal proportions at the end of the study period. This was very closely followed by the treatments T_6 (soil : sand : 1 month decomposed garbage), T_5 (soil : sand : 2 week decomposed garbage) and T_4 (soil : sand : fresh garbage). Thus in teak, a positive correlation could be observed between the period of decomposition of garbage and height growth. Similar results were also observed in cowpea by Saravanan and Baskar (1997).

A critical analysis of the data of mangium revealed that it followed almost a similar trend as that of teak as far as height is concerned. Here also, the seedlings subjected to the treatment T_3 (soil : sand : cow dung) recorded maximum height (62.9 cm) at the end of the study period. An important feature with regard to height is that the percentage increment in height was higher in mangium compared to teak. The average height at the end of the study was 46 per cent more than the average height of teak during the same period. The studies conducted in College of Forestry have also revealed the fast growing nature of mangium seedlings both in nursery and main field conditions (Gopikumar, 1995). Ani (1992) observed a positive trend in height growth in teak when a mixture of soil, vermiculite and cow dung was used as potting media. The height growth of *Eucalyptus urophylla* seedlings was found to be maximum in pure latosol and that of *Maesopsis eminii* was greater in a medium with soil and sand in the ratio 1:3 (Daryono, 1982). Maximum height growth occurred in the medium containing cow dung may be due to the improved nutrient status and water retention capacity of the media. Similarly composting improves the nutrient status of the garbage as reported by many researchers and this may be the reason for the better performance of the media containing composted garbage.

With regard to collar girth, the seedlings of both teak and mangium showed a trend almost similar to that of height growth. At the end of the study, a maximum girth of 5.49 mm was recorded by teak whereas in the case of mangium, the relative girth was 5.31 mm. In both the cases, the treatment containing soil, sand and cow dung recorded maximum value for girth closely followed by the treatment containing soil, sand and one month decomposed garbage in equal proportions. The collar girth was very poor in the treatment containing fresh and two week decomposed garbage. A scrutiny of the data also reveal that even though teak recorded maximum girth at the end of study, the maximum increment was noticed in mangium. Biradar *et al.* (1998) observed better collar girth and shoot growth in the case of *Azadirachta indica* seedlings as a result of addition of vermicompost to soil. Devaranavadagi and Sajjan (1997) evaluated the effect of potting media on vigour index of *Acacia nilotica* and found that an equal proportion of composted tank silt, farmyard manure and sand in 1:3:1 ratio promoted diameter growth. Addition of cow dung can improve soil physical properties and also nutrient availability and this may be responsible for better growth in media with cow dung. Khalilian and

Sullivan (1997) reported that addition of composted garbage to soil reduce bulk density, increase porosity, water holding capacity and improve nutrient availability. This can be the probable reason for better performance of seedlings in media with composted garbage.

In teak, the treatment T_3 (soil : sand : cow dung) produced maximum leaf area at the end of the fourth month of study (1237.68 cm^2) and subsequently it gradually reduced till the end of the study. In mangium, all the treatments showed an increasing trend with regard to leaf area throughout the period of study and the maximum leaf area at the end was recorded by the seedlings subjected to the treatment T_6 (soil : sand : 1 month decomposed garbage). Wireland (1985) noted that plants with higher rate of leaf growth probably had a higher photosynthetic efficiency and growth potential. The decreasing trend in leaf area of teak from the fifth month is due to its deciduous nature while the increasing trend in mangium is due to its evergreen nature.

5.3 Effect of potting media on fresh and dry weight of seedlings

The results of the study also revealed significant differences between treatments with regard to shoot fresh and dry weights. Teak and mangium followed a similar trend as far as the fresh and dry weight of shoots are concerned. In both the cases, the treatment containing soil, sand and cow dung in equal proportions recorded maximum fresh and dry weight at the end of the study. This treatment was closely followed by the treatment T_6 (soil : sand : 1 month decomposed garbage). A close perusal of the data reveal that teak seedlings recorded an initial high value for shoot weight than mangium, but towards the end of the study, in many treatments, mangium was performing better. This is definitely due to the high rate of growth of mangium compared to teak as reported earlier by many workers. Hazara and Tripathi (1986) reported that biomass production is a function of photo synthetically active radiation (PAR). Ward *et al.* (1981) noticed greater shoot weight of sugar maple seedlings when grown in green house medium. It is persumed that effective utilisation of available solar energy and also the availability of ample supply of nutrients especially nitrogen may be the reason for the better performance of seedlings grown in treatments T_3 (soil : sand : cow dung) and T_6 (soil : sand : 1 month decomposed garbage).

5.4 Effect of potting media on root growth parameters

An analysis of the data in teak reveal that the treatments containing garbage were performing better compared to other treatments with regard to root growth parameters. Similar trends were reported by Radha and Panigrahi (1998). They used solid waste to raise tree crops in pot experiments at varying concentration of 25, 15 and 5 per cent. A marked stimulation of root length and root fresh weight was observed at 5 per cent concentration. The treatments exerted significant influence on root weight of teak. Eventhough the treatment T_3 (soil : sand : cow dung) produced a better root growth in the earlier stages, a reduction in the rate of growth was noticed towards the end. At the end of the sixth month, the treatment T_5 (soil : sand : 2 week decomposed garbage) performed better as far as root fresh and dry weights are concerned.

In the case of mangium, the treatment T_3 (soil : sand : cow dung) showed better performance with regard to all root growth attributes. Ritchie (1982) reported that carbohydrates and growth regulators in single or in combination produced by the shoots are necessary for root growth. There was a positive relationship between stored carbohydrates or photosynthates present in the stem and development of healthy root system (Davis *et al.*, 1990). This aspect is also well defined in the present study also. The treatments those proved superior in teak and mangium with respect to root weight were having high shoot weight also. The difference in root biomass between treatments may be due to the variability in the level of photosynthesis and the translocation of photosynthates from the shoots to the roots.

5.5 Effect of potting media on chlorophyll content of seedlings

In both teak and mangium, various treatments could not exert any significant influence on the chlorophyll content of seedlings. However, a close study of the data reveal that the treatment containing soil, sand and cow dung was showing a slightly better performance with regard to chlorophyll content in the leaves. Most of the treatments registered an increase from the initial chlorophyll content during the first month to the final chlorophyll content at the end of the sixth month. The treatments T_1 (soil alone) and T_2 (soil : sand) were found to be poor with regard to chlorophyll content. Chlorophyll content of plants generally decides their photosynthetic potential and growth. Bruah (1990) reported better growth and yield of rainfed wheat at a higher chlorophyll content. In the present study also the treatments that registered higher chlorophyll content in teak and mangium was generally showing better results with regard to their growth attributes. The variability in the chlorophyll content of teak and mangium can be attributed to the differences in their ontogeny, lifecycle, leaf characteristics etc.

5.6 Effect of potting media on nutrient content of seedlings

In both teak and mangium, the seedlings grown in treatment T_3 (soil : sand : cow dung) recorded maximum concentration of nitrogen throughout the period of study. A close examination of the data also reveal that seedlings of mangium showed better nitrogen content than teak with respect to all treatments during the entire period of study. Nitrogen has pronounced effect on the growth behaviour of seedlings particularly with regard to shoot growth. In cashew seedlings grown in sand culture, nitrogen deficiency resulted in reduced height, girth and leaf area (Gopikumar and Aravindakshan, 1988). This aspect is well explained in the present investigation also. The seedlings which showed high tissue nitrogen concentration showed better performance with regard to shoot growth attributes viz., height, collar girth, fresh weight and dry weight. The high nitrogen content in plants suggests an efficient internal cycling of nutrients and also a good availability of nitrogen in the soil (Krishnan, 1986). In the present study the presence of cow dung in the treatment T_3 (soil : sand : cow dung) would have adjusted the C:N ratio and thereby increased the nitrogen availability of soil which subsequently resulted in high tissue nitrogen content.

Several scientific studies reveal that composting of garbage improve the nutrient availability. This trend was not so pronounced in the present study except in the case of nitrogen. According to Qui *et al.* (1987), during composting severe humification occurs and this cause change in pH which prevents the easy availability of nutrients.

Maximum concentration of phosphorus throughout the study period was recorded by seedlings grown in the treatment containing soil, sand and cow dung in equal proportion. Though the treatment T_3 (soil : sand : cow dung) recorded maximum concentration of phosphorus, the increment per cent from the initial value was low, when compared to treatment T_1 (soil alone) and T_2 (soil : sand). In the case of mangium also, at the end of the study period, maximum concentration of phosphorus was recorded by seedlings subjected to the treatment T_3 (soil : sand : cow dung). However, during the initial period of study, the treatments T_2 (soil : sand) and T_6 (soil : sand : 1 month decomposed garbage) performed better than the treatment T_3 (soil : sand : cow dung) with regard to P content. Generally phosphorous play an important role in a very large number of enzyme reactions that depend on phosphorylation (Greulach, 1973). This influence shoot growth parameters such as height, leaf area, collar girth etc. by acting as a structural component of all constituents and other metabolically active compounds (Agarwala and Sharma, 1976). It is also an established fact that P is the major controlling factor for energy in all living cells and as a constituent of nucleoproteins, it is concerned with cell decision also (Epstein, 1978). Wen-Guang *et al.* (1997) used sewage sludge as a component of potting media for raising *Phaseolus vulgaris* seedlings and found that the plant samples showed less concentration of nutrients especially phosphorous. According to him this was due to the fixation of phosphorous by Fe and Al.

Unlike in the case of nitrogen and phosphorus, in teak, maximum concentration of potassium at the end of the study period was recorded by seedlings grown in the treatment T_1 (soil alone). However, Boringer (1982) has reported that K activates protein synthesis and N metabolism and have a direct influence on cell division resulting in a higher cell number. In the case of mangium, the treatment T_3 (soil : sand : cow dung) ranked first as far as potassium content was concerned. This treatment was performing better with regard to shoot growth attributes. In cashew, absence of K adversely affected shoot growth parameters except the girth of seedlings (Gopikumar and Aravindakshan, 1988). Potassium has several physiological and biochemical roles in protein synthesis (Alan Wild, 1988). It is required in large concentration to activate many enzymes and to neutralise anions. In the present study the addition of cow dung would have improved the availability of K in the medium which finally have resulted in high K concentration in plant tissues.

From the above discussions, it is clear that potting media containing one month composted garbage is almost equally good when compared to potting media containing cow dung, in terms of growth of teak and mangium. With regard to many growth attributes, these two treatments were found to be on par. The addition of fertilizers like urea and superphosphate in small quantities to composted garbage will further improve the quality of potting media. This has been proved in the case of vegetables grown in potting media containing nutrient enriched garbage. But little is being done in the case of forest seedlings. The present studies clearly indicate the scope of detailed further investigations using various types of waste materials on growth of forest tree seedlings.

SUMMARY

SUMMARY

In the modern world, at all levels of development, human beings produce lot of domestic and industrial wastes. These wastes have created a real threat not only causing air and water pollution but also making the soil toxic and unsuitable for cultivation and even for afforestation. Apart from the point of view of public health, it has become impossible to dispose these wastes safely. Some preliminary studies reveal that garbage could be used for cultivation of vegetables particularly when grown in pots. But information regarding the effect of these solid wastes including garbage on the growth of trees, especially tree seedlings are very scanty.

The present study was carried out in the College of Forestry, Kerala Agricultural University, Vellanikkara to evaluate the effect of various potting media containing garbage on the growth and vigour of teak and mangium seedlings in the nursery. The salient findings of the experiment are summarised below.

(1) Final survival rate of teak seedlings was not greatly affected by potting media containing garbage. But in mangium, substantial influence was observed with regard to survival rate. Survival rate in media containing fresh garbage was 53 per cent while it was 64 per cent in decomposed garbage.

(2) In both teak and mangium, throughout the study period, maximum height and girth increase was observed when seedlings were grown in potting medium containing soil, sand and cow dung in equal proportions. In

general, mangium seedlings recorded more growth increment compared to teak in most of the potting media.

(3) Teak seedlings when grown in treatment T_3 (soil : sand : cow dung), recorded maximum leaf area during the fourth month of study and after that a gradual decrease was observed. However, in mangium the treatment T_6 (soil : sand : 1 month decomposed garbage) recorded maximum leaf area at the end of the study period. Moreover, a positive trend in leaf area increase was noticed here.

(4) Throughout the study period, maximum shoot biomass both in terms of fresh and dry weight was recorded by the seedlings grown in the medium consisting of soil, sand and cow dung, which was closely followed by the treatment with soil, sand and 1 month decomposed garbage. This was true for both teak and mangium.

(5) Observations pertaining to root biomass revealed that in teak, seedlings raised in potting medium containing soil, sand and two week decomposed garbage recorded maximum value whereas in mangium, the treatment T_3 (soil : sand : cow dung) recorded maximum root biomass at the end of the study period. Almost a similar trend was observed throughout the period of study.

(6) In both teak and mangium, the media containing one month and two week decomposed garbage produced maximum number and spread of roots respectively.

(7) In general, chlorophyll content of seedlings was not found to be significantly influenced by potting media. However, there was a slight increase in chlorophyll 'a' content in seedlings of teak and mangium

when grown in medium containing soil, sand and cow dung in equal proportions.

(8) Seedlings of teak subjected to the treatment T_2 (soil : sand) showed a substantial increase in chlorophyll 'b' content at the end of study period. However, in mangium the treatment T_5 (soil : sand : 2 week decomposed garbage) registered maximum content of chlorophyll 'b' at the end of study.

(9) With regard to total chlorophyll content, the increase was more pronounced in teak seedlings grown in treatments T_4 (soil : sand : fresh garbage) and T_6 (soil : sand : 1 month decomposed garbage) while in mangium, the treatment T_3 (soil : sand : cow dung) was ranking first as far as total chlorophyll was concerned.

10) Maximum concentration of nitrogen in teak and mangium was observed in the seedlings grown in the treatment T_3 (soil : sand : cow dung). This trend continued till the end of the study. With regard to phosphorous, in both teak and mangium, the treatment T_3 (soil : sand : cow dung) recorded maximum concentration at the end of the study. Seedlings subjected to the treatment T_1 (soil alone) registered maximum concentration of potassium in teak, whereas in mangium the treatment T_3 (soil : sand : cow dung) recorded maximum value for potassium at the end of the study period.

(11) Based on the observation on growth attributes, chlorophyll content and nutrient uptake, seedlings grown in potting media containing soil, sand with cow dung or one month decomposed garbage was proved to be better when compared to all other treatments. Similarly garbage, both fresh and decomposed in general is producing less deleterious effect on teak compared to mangium.

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APPENDIX

APPENDIX

WEATHER DATA (June 1999 - Nov. 2000)

Month	Temperature		Rainfall	Relative humidity	
	Maximum	Minimum		Morning	Evening
May 1999	33.7	24.4	117.2	88	56
June	29.4	23.0	500.2	94	75
July	28.4	23.0	823.3	96	82
August	29.8	22.9	260.1	94	73
September	31.6	23.4	28.4	89	63
October	30.5	23.2	506.2	94	75
November	31.4	22.7	9.1	81	57
December	30.7	22.7	0.0	72	48
January 2000	32.9	23.2	0.0	76	43
February	33.3	22.8	4.6	85	52
March	35.6	23.9	0.0	87	46
April	34.0	24.6	67.9	89	59
May	33.7	24.4	117.2	88	56
June	29.6	22.8	602.0	94	77
July	28.8	21.9	354.0	93	70
August	29.1	22.6	518.8	94	79
September	30.7	23.0	198.1	91	70
October	30.7	22.7	262.2	91	68
November	33.3	23.1	41.3	77	54
December	30.4	22.0	11.2	70	48

MUNICIPAL GARBAGE AS A COMPONENT OF POTTING MEDIA FOR SEEDLINGS OF SELECTED FOREST TREE SPECIES

By

ADERSH. M.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

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ABSTRACT

The present study was undertaken at College of Forestry, Kerala Agricultural University, Vellanikkara, Thrissur to evaluate the effect of potting media containing garbage on the growth and vigour of teak (*Tectona grandis* Linn. F.) and mangium (*Acacia mangium* Willd) seedlings. The study revealed that when garbage, especially fresh garbage, was used as a component of potting media, no significant effect was observed on survival rate of seedlings of teak, but a high rate of mortality was observed in the case of mangium.

The potting media containing soil, sand and cow dung in equal proportions produced the best results with regard to shoot growth parameters like height and girth. However, the potting media containing soil, sand and one month decomposed garbage also produced similar results which was on par with the best treatment. Teak seedlings registered higher root biomass, root spread and root number when grown in the media containing garbage especially one month decomposed garbage. Unlike teak, in the case of mangium the treatment soil, sand and cow dung in equal proportions was proved to be the best with regard to root growth parameters.

In both teak and mangium, chlorophyll content was not found to be significantly influenced by any media. Seedlings grown in the media containing soil, sand and cow dung in equal proportions recorded higher uptake and concentration of nitrogen, phosphorus and potassium in the plant tissue when

compared to all other treatments. This was true both in the case of teak and mangium.

In general, the treatments T_3 (soil : sand : cow dung) and T_6 (soil : sand : 1 month decomposed garbage) were proved to be better when compared to all other treatments. In many cases these two treatments were found to be on par.