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# STANDARDISATION OF POTTING MEDIUM FOR BALANCED NUTRITION OF TEAK SEEDLINGS

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## ABSTRACT OF PROJECT PROPOSAL

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|---|---|---|---|
| 1 | Project No. | : | KFRI 397/03 |
| 2 | Title of project | : | Standardisation of potting medium for balanced nutrition of teak seedlings |
| 3 | Objectives | : | 1.To improve the nutrient status of potting media with different proportion of soil, compost, sand and coir pith for vigorous growth of teak seedlings in root trainers<br>2.To find out the relationship between the nutrient content of potting media and growth and nutrition of teak seedlings<br>3.To enumerate the microbial status of each potting medium and identify the beneficial organisms<br>4.To find out the best potting medium in relation to the growth and nutrition of teak seedlings |
| 4 | Duration | : | 3 years |
| 5 | Funding Agency | : | KFRI -Plan |
| 6 | Project Team | | |
| | Principal Investigator | : | M.P. Sujatha, Soil Science Department |
| | Associates | : | E.J.Maria Florence, Extension and Training Division |

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## ABSTRACT

Introduction of root trainer technology in forestry sector necessitated the use of ingredients with light weight preferably compost as a major component of potting media. The studies on root trainer technology at KFRI (Chacko *et al,* 2002) recommended the use of either coir pith compost or compost made out from mixed weeds as major component of potting medium along with the application of DAP and micro nutrients at an interval of one to two days as foliar spray for raising teak seedlings. In order to avoid the continuous application of DAP and micronutrients in the above recommendation, this study was carried out to find out a proper combination of coir pith compost and mixed weed compost to serve as a good potting medium for the balanced nutrition and healthy growth of teak seedlings in root trainers. For this, sixteen combinations of a composts with sieved soil and sand were prepared and filled in root trainer blocks (one block containing 24 cells) with four replications based on the recommendations of Chacko *et al.* (2002). The results of the study in general revealed that mixing coir pith compost with mixed weed compost have altered the chemical condition of potting medium more favourable for healthy plant growth than the individual compost alone. The combination of commercial coir pith compost, mixed weed compost, soil and sand in the proportion 40:40:15:5 and 60:20:15:5 respectively were found successful for the healthy growth of teak seedlings in root trainers. The study also suggested to minimise the use of urea and rock phosphate during the preparation of mixed weed compost, if it is used as a major ingredient in the potting mix in root trainers. The total number of bacteria and actinomycetes present in potting media containing coir pith compost was more than those with washed coir pith In the case of fungal colonies, not much variation was found in both potting mixtures containing coir pith compost and washed coir pith. The beneficial microbes identified from the potting media were nitrogen fixers and phosphate solubilisers. But the number of these microbes present in different combinations was very low.

# 1. INTRODUCTION

Teak being one of the high valued timber species in Kerala, plantations of this species is being established annually in an area of about 1000 ha. in the State mainly by the Kerala Forest Department. Establishment of healthy plantations obviously demand production of healthy seedlings and very recently root trainer grown seedlings are getting more attention in the forestry sector owing to their multifarious advantages such as easy handling, requirement of less space and potting mix etc. over the conventional poly bags. The studies on root trainer technology at KFRI (Chacko *et al,* 2002 ) recommended the use of either coir pith compost or compost made out of mixed weeds as major component of potting medium along with the application of DAP and micro nutrients at an interval of one to two days as foliar spray for raising teak seedlings. Even though compost from mixed weeds is supposed to be a rich source of plant nutrients, the seedlings grown in this media without frequent application of micronutrients often seemed to be unhealthy with some characteristic foliar symptoms of nutritional disorders. The alkaline nature of such compost is reported (Chacko *et al.*, 2002) as one of the key factors for the expression of nutritional disorders by way of restricting the absorption of optimum quantity of micro nutrients needed by teak seedlings. More over, relatively high content of macro nutrients in these composts leads to nutrient interactions there by suppressing the absorption and translocation of micronutrients leading to the foliar expression of their deficiency. On the contrary, the compost made out of coir pith is acidic in nature with very poor content of nutrients needed for the plant growth. Hence, the plants raised in such composts need to be supplied with nutrients very frequently. In this context, the present study is to find out a proper combination of coir pith compost and mixed weed compost to serve as a good potting medium for the balanced nutrition and healthy growth of teak seedlings in root trainers without any external application of nutrients. The main objectives of the study are :

1. To improve the nutrient status of potting media with different proportion of soil, weed compost, sand and coir pith compost for vigorous growth of teak seedlings in root trainers

2. To find out the relationship between the nutrient content of potting media and growth and nutrition of teak seedlings

3. To enumerate the microbial status of each potting medium and identify the beneficial organisms

4. To find out the best potting medium in relation to the growth and nutrition of teak seedlings

## 2. REVIEW OF LITERATURE

Root trainer technology for raising seedlings in nurseries was adopted in western countries as early in the 1940s, but in India it was not in practice in majority of forest nurseries even in late 1990s . It is reported that the seedlings produced through root trainer technology were sturdy due to the morpho-physiological changes induced in the plants and they can withstand shock better than other plants (Rao *et al.*(2001). Apart from prolonged drought resistance through the well developed root system, root trainer grown seedlings are reported to have other advantages such as easy handling and transportation, requirement of less space and potting mix, environmental cleanliness by avoiding poly bags etc. The first ever trials on raising teak root trainer nursery in India was launched by Khedkar and Subramanian (1997) and the teak plantations raised from root trainer seedlings were found to have better growth performance than the traditional stump planting (Khedkar, 1999., Rao *et al.*2001).

Potting mixture is the most important factor in influencing the health and vigour of seedlings produced in root trainers, which is mainly decided by the physical and chemical properties of the potting medium. Good potting medium is characterised by light weight, friability, easy blendability, good water holding capacity, drainage, porosity, slight acidity, low bulk density, free from pathogens and insects and low inherent fertility etc. (Chakrabarti *et al.* 1998). Ginwal *et al.* (2001) standardised two combinations of potting medium (sand and compost in the ratio 1:4 and charcoal and compost in the ratio 1:4) for growing *Acacia nilotica* seedlings in root trainers. For growing the seedlings of *Dalbergia sissoo,* potting media containing

sand, soil and compost was found satisfactory (Ginwal *et al.*, 2002). Khedkar, and Subramanian (1996 and 1997) used the combinations of soil, sand and farmyard manure with required amendments for raising the teak seedlings in root trainers. Chacko *et al,* (2002) recommended the use of either coir pith compost or compost made out from mixed weeds as major component of potting medium along with the application of DAP and micro nutrients at an interval of one to two days as foliar spray for raising teak seedlings in root trainers under Kerala condition.

## 3. IMPROVEMENT OF POTTING MEDIA WITH RESPECT TO pH AND NUTRIENTS

### 3.1 Materials and Methods

Different types of composts such as mixed weed compost, commercial coir pith compost and washed coir pith compost obtained from forest central nursery Chettikkulam (in Chalakkudy), Poothotta (in Thripunithura) and Pattikkad (in Thrissur) respectively were air dried.

Based on the recommendations of Chacko *et al.* (2002) in Table 1, sixteen combinations of the above composts along with sieved soil and sand (Table 2) were prepared and filled in root trainer blocks (one block containing 24 cells) with four replications.

Samples from each combination were taken separately and kept ready for laboratory analysis. Germinated teak seeds were dibbled in these root trainers and they were arranged in Completely Randomised Design. Growth of plants were observed for the development of nutritional disorders. Regular watering and necessary plant protection measures were carried out.

Table 1. Potting media recommended by Chacko *et al* (2002) for raising teak seedlings in root trainers

| Sl. No. | Potting medium |
|---|---|
| 1 | Commercial coir pith compost -75%<br>Soil - 25% |
| 2 | Mixed weed compost - 80%<br>Soil - 15%<br>Sand - 5% |
| With DAP and multiplex application at an interval of one to two days as foliar spray | |

Table 2. Various combinations of potting media used in the experiment

| Sl No. | Commercial coir pith compost | Mixed weed compost | Soil | Sand |
|---|---|---|---|---|
| 1 | 40 | 20 | 20 | - |
| 2 | 50 | 25 | 25 | - |
| 3 | 25 | 50 | 25 | - |
| 4 | 40 | 40 | 15 | 5 |
| 5 | 60 | 20 | 15 | 5 |
| 6 | 20 | 60 | 15 | 5 |
| 7 | 75 | - | 25 | - |
| 8 | - | 80 | 15 | 5 |
| | Washed coir pith compost | Mixed weed compost | Soil | Sand |
| 9 | 40 | 40 | 20 | - |
| 10 | 50 | 25 | 25 | - |
| 11 | 25 | 50 | 25 | - |
| 12 | 40 | 40 | 15 | 5 |
| 13 | 60 | 20 | 15 | 5 |
| 14 | 20 | 60 | 15 | 5 |
| 15 | 75 | - | 25 | - |
| 16 | - | 80 | 15 | 5 |

Samples from each combination of potting media were analysed for pH (1: 2.5 water suspension), plant available N (alkaline permanganate method), Bray extractable P, exchangeable K (neutral normal ammonium acetate extraction followed by flame photometry) and exchangeable Ca and Mg (neutral normal ammonium acetate extraction followed by EDTA titrimetry).

### 3.2 Results and discussion

This study mainly focus on changing the chemical composition of potting media with the view of making an ideal condition with respect to pH and nutrients so that plants get balanced nutrition for healthy and vigorous growth without any external supply of nutrients.

The studies on root trainer technology at KFRI (Chacko *et al.*, 2002) recommended the use of coir pith as potting medium along with the application of DAP and micro nutrients at an interval of one to two days as foliar spray for raising teak seedlings. The content of nutrients in coir pith compost was not enough to support healthy growth of plants and hence demanded external supply of nutrients. But the compost made out of mixed weed species was richer in plant nutrients than coir pith. So this study mainly aims to find out an optimum combination of coir pith compost and mixed weed compost to serve as a good potting medium for the healthy and vigorous growth of seedlings without the expression of any nutritional disorders during their growth period. For this, sixteen combinations of mixed weed and coir pith composts along with soil and sand as described under methodology were prepared and used for growing teak seedlings in root trainers.

Chemical analysis of individual components of potting media used for the present study (Table 3) revealed that mixed weed compost was alkaline in reaction with a pH of 7.5 while commercial coir pith compost and washed coir pith were acidic with a pH of 4.2 and 4.9 respectively. The alkaline nature of mixed weed compost is supposed to be due to the release of ammonia during composting. Immature nature of compost also may contribute higher level of ammoniacal N leading to alkalinity.

Table 3. pH and plant available nutrient content in various types of compost

| | pH | N, % | P, ppm | K,% | Ca,% | Mg, % |
|---|---|---|---|---|---|---|
| Mixed weed compost | 7.5 | 0.48 | 230 | 0.97 | 0.7 | 0.18 |
| Comm.coir pith compost | 4.2 | 0.27 | 62 | 0.10 | 0.09 | 0.03 |
| Washed coirpith | 4.9 | 0.09 | 14 | 0.09 | 0.06 | 0.02 |

Regarding the nutrient composition of the composts, most of the nutrients in composts are bound within organic molecules. Nutrients which are in the inorganic forms are immediately available for the absorption by the plants. Among the three types of composts, mixed weed compost contained higher content of plant available nutrients such as N, P, K, Ca and Mg while the washed coir pith contained the lowest and commercial coir pith in between. Among the nutrients, N was in higher quantity in all the composts followed by Ca, K, Mg and P. Washed coir pith and commercial coir pith compost were very poor in nutrients compared to mixed weed compost. Relatively higher content of nitrogen in mixed weed compost and commercial coir pith compost might be due to its enrichment with urea during the process of composting. Higher content of N in mixed weed compost also may be due to its contribution from source materials containing higher content of N.

Chemical evaluation of eight potting media with different combinations of commercial coir pith compost and mixed weed compost (Table 4) revealed that mixing of above composts modified the pH of potting media from 4.5 to 6.6. The lowest pH of 4.5 was recorded in the $7^{th}$ combination where no mixed weed compost was included. Combination of mixed weed compost in equal and higher proportion with commercial coir pith compost changed the pH of potting medium to 6.3-6.6. In

Table 4. pH, EC and available nutrient content in various combinations of potting media

| Sl. No. | *CC:MW:So:Sa | pH | EC (dS/m) | N % | P ppm | K % | Na ppm | Ca % | Mg % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40 : 40 : 20 | 6.3 | 0.45 | 0.46 | 172 | 0.32 | 77 | 0.39 | 0.23 |
| 2 | 50 : 25 : 25 | 5.8 | 0.48 | 0.38 | 97 | 0.38 | 77 | 0.28 | 0.25 |
| 3 | 25 : 50 : 25 | 6.5 | 0.56 | 0.34 | 165 | 0.32 | 94 | 0.50 | 0.23 |
| 4 | 40 : 40 : 15 : 5 | 6.5 | 0.45 | 0.46 | 102 | 0.36 | 94 | 0.46 | 0.15 |
| 5 | 60 : 20 : 15 : 5 | 5.6 | 0.25 | 0.34 | 99 | 0.28 | 95 | 0.32 | 0.21 |
| 6 | 20 : 60 : 15 : 5 | 6.6 | 0.71 | 0.55 | 179 | 0.32 | 104 | 0.45 | 0.21 |
| 7 | 75 : - : 25 | 4.5 | 0.37 | 0.21 | 15 | 0.27 | 105 | 0.08 | 0.17 |
| 8 | - : 80 : 15 : 5 | 7.4 | 0.82 | 0.42 | 180 | 0.51 | 105 | 0.48 | 0.20 |
| | WC: MW:So:Sa | | | | | | | | |
| 9 | 40 : 40 : 20 | 5.8 | 0.36 | 0.34 | 148 | 0.39 | 132 | 0.36 | 0.17 |
| 10 | 50 : 25 : 25 | 6.0 | 0.28 | 0.46 | 109 | 0.24 | 150 | 0.35 | 0.18 |
| 11 | 25 : 50 : 25 | 6.4 | 0.30 | 0.46 | 130 | 0.38 | 150 | 0.46 | 0.20 |
| 12 | 40 : 40 : 15: 5 | 6.3 | 0.62 | 0.38 | 102 | 0.35 | 135 | 0.43 | 0.21 |
| 13 | 60 : 20 : 15 :5 | 5.9 | 0.35 | 0.34 | 113 | 0.23 | 115 | 0.29 | 0.16 |
| 14 | 20 : 60 : 15 : 5 | 6.5 | 0.79 | 0.42 | 172 | 0.39 | 118 | 0.51 | 0.18 |
| 15 | 75 : - : 25 : - | 5.9 | 0.02 | 0.38 | 118 | 0.07 | 118 | 0.31 | 0.12 |
| 16 | - : 80 : 15 : - :5 | 7.2 | 0.64 | 0.42 | 180 | 0.49 | 95 | 0.48 | 0.20 |
| 17 | Conventional media | 5.8 | | - | 48 | 0.028 | 24 | 0.052 | 0.024 |

*CC= commercial coir pith compost, MW= mixed weed compost, So= soil, Sa= sand, WC= Washed coir pith compost

other combinations where proportion of commercial coir pith was in less quantity compared to mixed weed compost, the pH values ranged between 5.6 and 5.8. When commercial coir pith compost was replaced by washed coir pith, pH values of potting media ranged between 5.8 and 6.5. Combinations in which mixed weed compost was not included and in comparatively lower proportion, pH values ranged between 5.8 and 6.0. However the results showed that combination of mixed weed compost with either commercial coir pith compost or washed coir pith could bring

the pH between 5.5 to 6.5, which is optimum for the absorption of nutrients by the teak seedlings.

Table 5. C: N ratio of various combinations of potting media

| Sl. No. | *CC:MW:So:Sa | Org. C (%) | Total N (%) | C:N |
|---|---|---|---|---|
| 1 | 40 : 40 : 20 | 12.1 | 1.96 | 6.2 |
| 2 | 50 : 25 : 25 | 13.0 | 1.10 | 11.8 |
| 3 | 25 : 50 : 25 | 12.1 | 1.10 | 11.0 |
| 4 | 40 : 40 : 15 : 5 | 15.0 | 1.56 | 9.6 |
| 5 | 60 : 20 : 15 : 5 | 13.4 | 1.28 | 10.5 |
| 6 | 20 : 60 : 15 : 5 | 13.8 | 3.90 | 3.5 |
| 7 | 75 : - : 25 | 10.1 | 0.84 | 12 |
| 8 | - : 80 : 15 : 5 | 11.9 | 2.80 | 4.3 |
| | *WC: MW:So:Sa | | | |
| 9 | 40 : 40 : 20 | 14.3 | 1.68 | 8.5 |
| 10 | 50 : 25 : 25 | 11.2 | 1.96 | 5.7 |
| 11 | 25 : 50 : 25 | 12.7 | 2.24 | 5.7 |
| 12 | 40 : 40 : 15: 5 | 14.4 | 1.68 | 8.6 |
| 13 | 60 : 20 : 15 :5 | 8.9 | 1.40 | 6.4 |
| 14 | 20 : 60 : 15 : 5 | 13.8 | 1.96 | 7.0 |
| 15 | 75 : - : 25 : - | 10.4 | 1.12 | 9.3 |
| 16 | - : 80 : 15 : - :5 | 14.3 | 1.96 | 7.3 |
| | Conventional potting media | 0.43 | 0.038 | 11.3 |

*CC= commercial coir pith, MW= mixed weed, So= soil, Sa= sand, WC= washed coir pith

A high concentration of soluble salts in the plant growth medium is detrimental to germinating seeds and to plant growth. Soluble salts in the range 0.35-0.64 dS/m is usually a desirable range for most of the plants (Warncke and Krauskopf, 1983). In the present experiment, the soluble salt content in most of the potting media except 6$^{th}$

$8^{th}$ , $14^{th}$ and $16^{th}$ (Table 4) was within the above range and hence desirable for the plant growth.

The content of plant available N in the eight potting media with different combinations of commercial coir pith compost and mixed weed compost varied from 0.21 to 0.55% (Table 4). The lowest value of 0.21% was recorded in the $7^{th}$ combination where no mixed weed compost was included. Combination of mixed weed compost in equal and higher proportion with commercial coir pith compost raised the N content of potting medium to 0.40%. In other combinations where proportion of commercial coir pith was in higher quantity compared to mixed weed compost, the values ranged between 0.34 and 0.38%. When commercial coir pith compost was replaced by washed coir pith, the values ranged between 0.34 and 0.46%. The results in general showed that content of N in all the combinations of potting media was very high compared to the conventional potting media in poly bags.

Extractable P content in all the combinations except $7^{th}$ were very high ranging from 97 to 180 ppm. In the $7^{th}$ combination where mixed weed compost was not added, the P content was comparatively low (15 ppm.).

Exchangeable K content varied from 0.07 to 0.51% and the lowest content was in the combination where mixed weed compost was not added. The combination with maximum mixed weed compost contained higher levels of K.

Exchangeable Ca content was also very high in all the combinations except $7^{th}$ where mixed weed compost was not added, and the values ranged between 0.28 to 0.51%. In $7^{th}$ combination it was 0.08%. Exchangeable Mg was also towards higher level, with the values ranging from 0.12 to 0.25%. The minimum content was recorded in the media, where mixed weed compost was not added.

The C:N ratio (Table 5) of all the combinations (Table 5) in general were at narrow range, most of the values lying below 10 (Table 5). The combinations where mixed weed compost was added recorded lower ratios, due to the higher content of N in them.

Thus the chemical analysis of various combinations of potting media in general revealed that mixing of mixed weed compost with coir pith compost has altered the pH and nutrient content of potting media. The combinations with higher proportion of mixed weed compost caused higher content of nutrients and soluble salts in the potting media, which are far more than in the conventional media. According to Chakrabarti *et al.* (1998) the growing media in root trainers must be slightly acidic with low inherent fertility and the C: N ratio must be less than 15 and this was met in most of the combinations used in the present experiment. However, based on the results, it is suggested to minimise the addition of urea and rock phosphate during the preparation of mixed weed compost, especially if it is used as an ingredient of potting medium in root trainers.

## 4. EXPRESSION OF DEFICIENCY SYMPTOMS IN RELATION TO THE NUTRITIONAL STATUS OF POTTING MEDIA

The plants grown in different combinations of potting media (Table 1) were monitored for the survival and the appearance of nutrient deficiency symptoms.

The seedlings grown in the $4^{th}$, $5^{th}$ , $7^{th}$ and $15^{th}$ combinations of potting media were found to have relatively higher survival percentage compared to other combinations (Table 6). Appearance of deficiency symptoms was either nil or relatively very few in $12^{th}$, $13^{th}$, $5^{th}$ and $4^{th}$ combinations and the nutritional disorders were very severe in $6^{th}$, $8^{th}$ , $14^{th}$ and $16^{th}$ combinations. In the $4^{th}$ and $5^{th}$ combinations, the ingredients of potting media were coir pith compost, mixed weed compost, and soil in the proportion 40:40:15:5 and 60:20:15:5 respectively. In $12^{th}$ and $13^{th}$ combinations also the proportion of the ingredients was the same as in $4^{th}$ and $5^{th}$ combinations, but the commercial coir pith was replaced by washed coir pith. Balanced nutrition of seedlings in these potting media may be due to the optimum pH needed for the absorption of all the essential nutrients. In $6^{th}$, $8^{th}$ , $14^{th}$ and $16^{th}$ combinations where seedlings showed severe deficiency symptoms contained relatively higher proportion of mixed weed compost. Hence those potting media had

Table 6. Survival and expression of foliar symptoms of nutrient deficiency in teak seedlings

| Sl. No. | *CC:MW:So:Sa | Survival, % | Plants showing nutrient deficiency symptoms, % |
|---|---|---|---|
| 1 | 40 : 40 : 20 | 72 | 24 |
| 2 | 50 : 25 : 25 | 68 | 36 |
| 3 | 25 : 50 : 25 | 33 | 50 |
| 4 | 40 : 40 : 15 : 5 | 92 | 4 |
| 5 | 60 : 20 : 15 : 5 | 96 | Nil |
| 6 | 20 : 60 : 15 : 5 | 45 | 100 |
| 7 | 75 : - : 25 | 82 | 26 |
| 8 | - : 80 : 15 : 5 | 24 | 96 |
| | *WC: MW:So:Sa | | |
| 9 | 40 : 40 : 20 | 64 | 20 |
| 10 | 50 : 25 : 25 | 72 | 32 |
| 11 | 25 : 50 : 25 | 50 | 25 |
| 12 | 40 : 40 : 15: 5 | 68 | Nil |
| 13 | 60 : 20 : 15 :5 | 75 | Nil |
| 14 | 20 : 60 : 15 : 5 | 38 | 92 |
| 15 | 75 : - : 25 : - | 88 | 13 |
| 16 | - : 80 : 15 : - :5 | 18 | 96 |

*CC= commercial coir pith, MW= mixed weed, So= soil, Sa= sand, WC= Washed coir pith

relatively elevated pH, soluble salts and higher nutrient content especially N and P contributed by the mixed weed compost which constituted the major portion of above potting media. Such potting media with higher content of nutrients in small containers of low volume capacity may be creating a hypertonic condition where

Fig. 1 Best potting media supporting healthy green seedlings

plant roots are not able to absorb and translocate some of the essential nutrients in the required proportion with other nutrients. Along with this trial, we analysed the nutrient content of potting mix in traditional teak nurseries. It was found that content of nutrients in traditional potting mix was far below than the mixed weed compost (Table 4 ) and this proclaims the hyper tonic condition in root trainers. Chacko *et al.* (2002) reported that mixed weed compost contained high amount of both macro and micro nutrients and the nutrient disorders in root trainer grown seedlings where mixed weed compost was the major ingredient of potting medium, were mainly due to the deficiency of Fe and Cu, caused due to the imbalance of

nutrients either during absorption or translocation. Coir pith, being a poor reservoir of nutrients, the foliar symptoms of plants in that media could be also due to the deficiency of macro nutrients. However, based on the results of this study it is suggested to minimise the use of urea and rock phosphate during the preparation of mixed weed compost, if it is used as an ingredient of potting mix in root trainers.

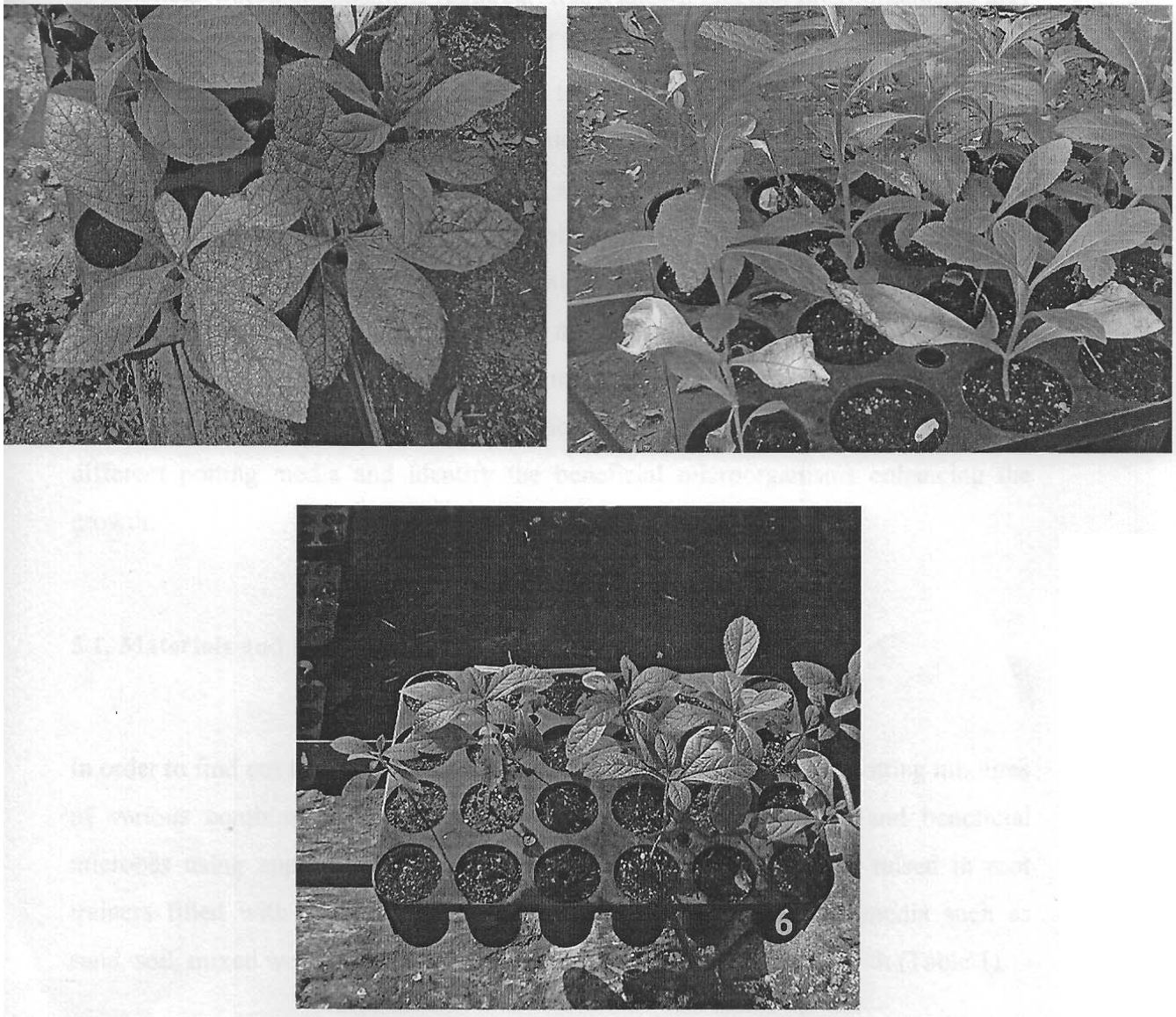


Fig..2 Potting media supporting seedlings with nutrient disorders

## 5. ENUMERATION OF THE MICROBIAL STATUS OF EACH POTTING MEDIA AND IDENTIFICATION OF THE BENEFICIAL ORGANISMS

Production of healthy seedlings is the basic requirement for establishing healthy plantations. For raising healthy seedlings, a nutritionally balanced potting media rich in beneficial micro organisms is required. It is a known fact that microorganisms play an important role in keeping the fertility of soil. Majority of microorganisms present in the soil are considered to be beneficial to higher plants. Organic matter addition enhances population levels of beneficial microorganisms. When organic matter such as compost or wood residues is added to soil, the natural organic matter content is raised considerably increasing carbon availability to microorganisms. It is assumed that the addition of compost or other organic matter to the soil stimulates the growth of saprophytic or non-pathogenic type of microorganisms. The present study is an attempt to select nutritionally rich potting media for raising healthy seedlings of teak and to enumerate different kinds of microorganisms in various combinations of different potting media and identify the beneficial microorganisms enhancing the growth.

### 5.1. Materials and Methods

In order to find out the microbial population of the potting media, the potting mixtures of various combinations were subjected to enumeration for total and beneficial microbes using appropriate cultural media. Teak seedlings were raised in root trainers filled with different concentration/combinations of potting media such as sand, soil, mixed weed compost, coir pith compost and washed coir pith (Table 1).

The selected samples of potting mixtures were kept in polythene containers and stored at 4 $^{o}$C till they were processed. Soil dilution plate method (Waksman and Fred, 1922 and Timonin, 1940) was used for isolation of microorganisms. For isolation, 10 g was transferred to 100 ml sterile water in 250 ml conical flasks. The samples were shaken thoroughly and appropriate dilutions were prepared, i.e., $10^{-3}$ for fungi and $10^{-5}$

for bacteria and actinomycetes. For enumerating beneficial microbes such as phosphate solubilisers and nitrogen fixers, Pikovskaya's agar and Jensen's agar were used respectively. Rose Bengal agar was used to isolate fungi, while starch casein agar and soil extract agar were used to isolate actinomycetes and bacteria respectively. One ml of the sample suspension was transferred to individual petri plates and appropriate media added. Five replicate petri plates were maintained for each medium. The petri plates were incubated in the dark and colonies of different microorganisms enumerated after appropriate time interval of 48 hours for bacteria, 6 days for fungi and 10-14 days for actinomycetes, phosphate solubilisers and nitrogen fixers.

### 5.2. Results

The populations of bacteria, fungi, actinomycete and beneficial microorganisms such as nitrogen fixers and phosphate solubilisers are given in Table 7.

Table 7. Population of bacteria, fungi, actinomycetes, nitrogen fixers and phosphate solubilisers

| *CC: MW:So:Sa | Bacteria $10^{-5}$ | Fungi $10^{-3}$ | Actinomycetes $10^{-5}$ | Nitrogen fixing bacteria $10^{-5}$ | Phosphate solubilisers $10^{-5}$ |
|---|---|---|---|---|---|
| 40 : 40 : 20 | 76 | 20 | 250 | - | - |
| 50 : 25 : 25 | 52 | 17 | 152 | - | - |
| 25 : 50 : 25 | 100 | 29 | 348 | - | - |
| 40 : 40 : 15 : 5 | 55 | 33 | 400 | - | - |
| 60 : 20 : 15 : 5 | 40 | 13 | 90 | 5 | - |
| 20 : 60 : 15 : 5 | 110 | 23 | 360 | - | - |
| 75 : - : 25 | 50 | 18 | 180 | - | 2 (bacteria) |
| - : 80 : 15 : 5 | 7 | 4 | 18 | - | - |
| *WC: MW:So:Sa | | | | | |
| 40 : 40 : 20 | 9 | 40 | 16 | | |
| 50 : 25 : 25 | 17 | 39 | 20 | 2 | - |
| 25 : 50 : 25 | 10 | 15 | 18 | 3 | 1(fungi) |
| 40 : 40 : 15: 5 | 4 | 12 | 10 | 1 | 2(fungi) |
| 60 : 20 : 15 :5 | 17 | 13 | 50 | - | - |
| 20 : 60 : 15 : 5 | 10 | 76 | 20 | - | - |
| 75 : - : 25 : - | 7 | 30 | 20 | 2 | - |
| - : 80 : 15 : - :5 | 19 | 4 | 20 | - | 1(bacterium) |

* CC= commercial coir pith, MW= mixed weed, So= soil, Sa= sand, WC=washed coir pith

*Bacteria:* It is clear from the Table 7 and Figs.3a, 3b that bacterial population was more in potting media containing coir pith compost than the washed coir pith. Among the different combination using coir pith compost, the bacterial number was very low in the combination having no coir pith compost.

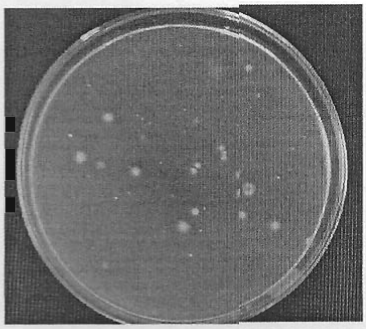

Fig. 3a. Bacteria isolated from coir pith compost

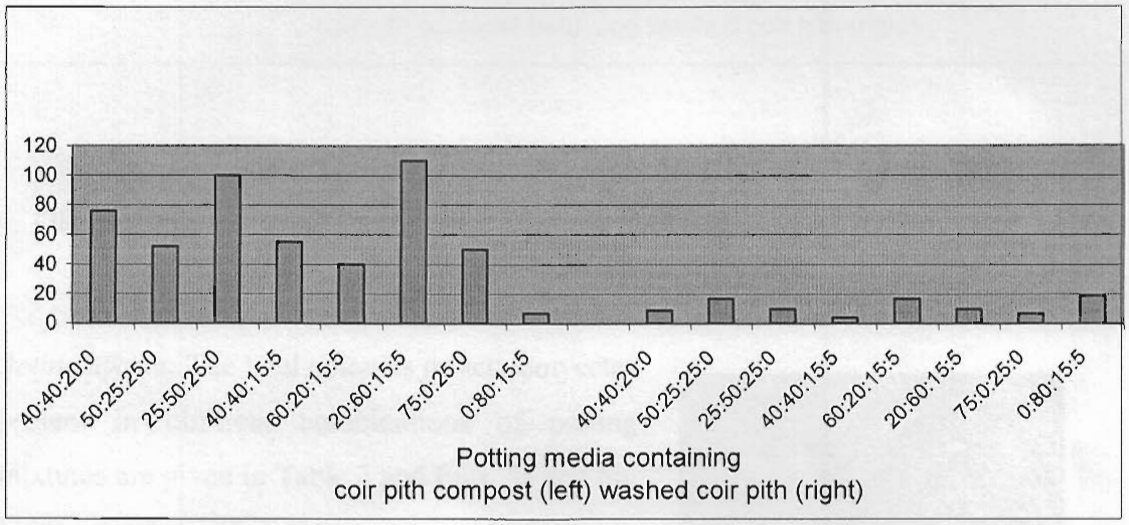


Figure 3b. Bacterial population ($10^{-5}$ $g^{-1}$ oven dry basis) in different types of potting media

*Fungi:* The number of fungal colonies in different combinations of potting mixtures is given in Table 7 and Figs. 4a and 4b. Among different types of potting mixtures maximum numbers of fungal colonies were observed in the potting mixture containing 40 % of coir pith compost, 40 % of mixed weed compost 15 % of soil and 5 % of sand.

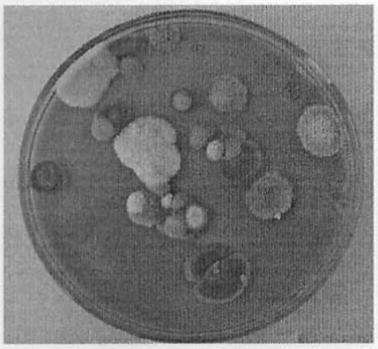

Fig. 4a. Fungi isolated from potting mixture (40:40:15:5)

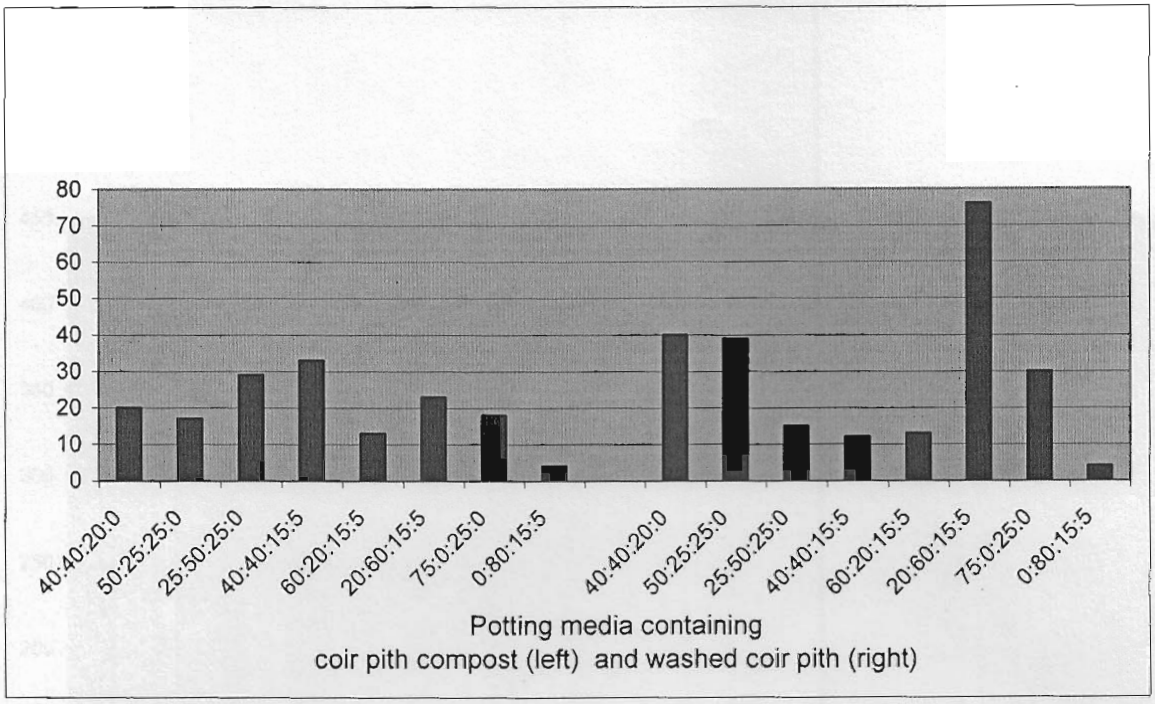


Fig. 4b. Fungal population ($10^{-3}$ $g^{-1}$ oven dry basis) in different types of potting media

*Actinomycete:* The total colonies of actinomycetes present in different combinations of potting mixtures are given in Table 7 and Figs. 5a and 5b. More number of actinomycete colonies was present in all combinations containing coir pith compost. But very less colonies were found in the combination which had no coir pith compost.

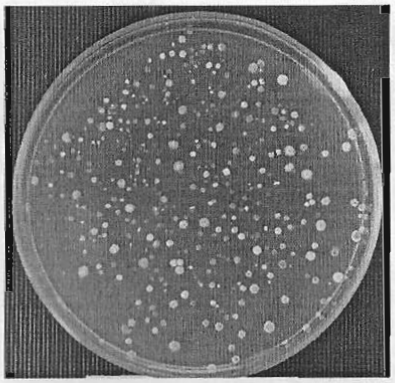

Fig. 5a. Actinomycetes isolated from potting mixture (40:40:15:5)

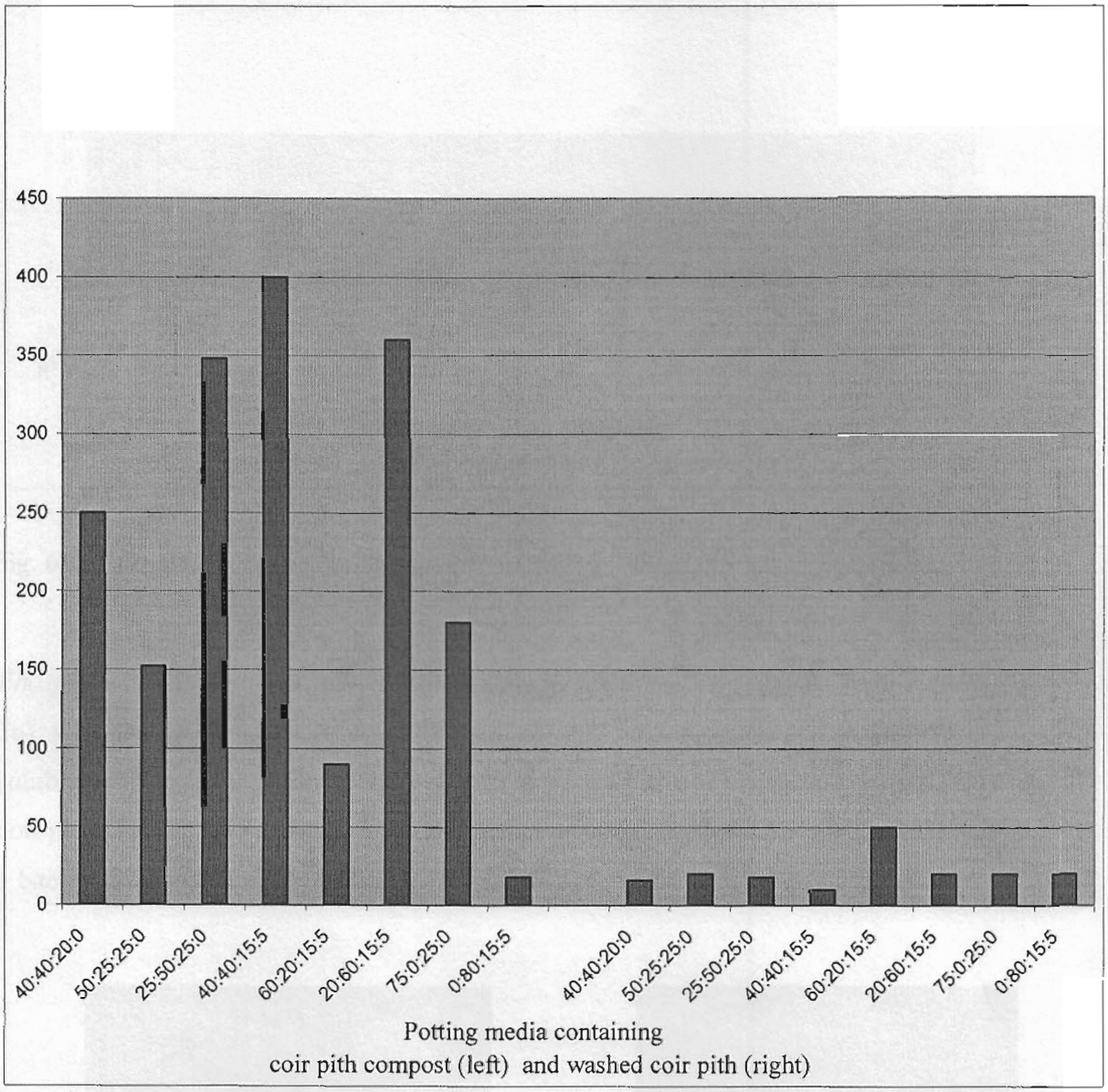


Fig. 5b. Actinomycete population ($10^{-5}$ $g^{-1}$ oven dry basis) in different types of potting media

*Nitrogen fixing bacteria*: The number of nitrogen fixing bacterial colonies in different combinations of potting mixtures is given in Table 2 and Figs.6a and 6b. Five nitrogen fixing bacterial colonies were present only in one combination of coir pith compost (40:40:15:5). In potting media containing washed coir pith 1-3 colonies of nitrogen fixers were isolated.

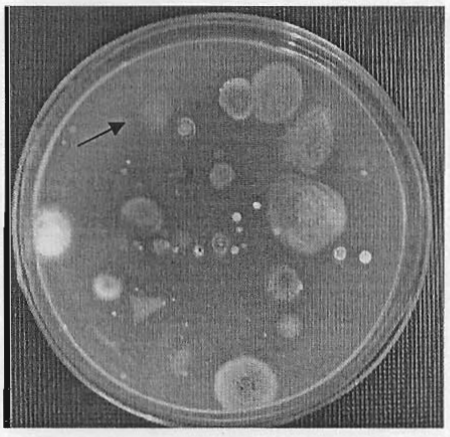

Fig. 6a. Nitrogen fixing bacteria in potting mixture (40:40:15:5)

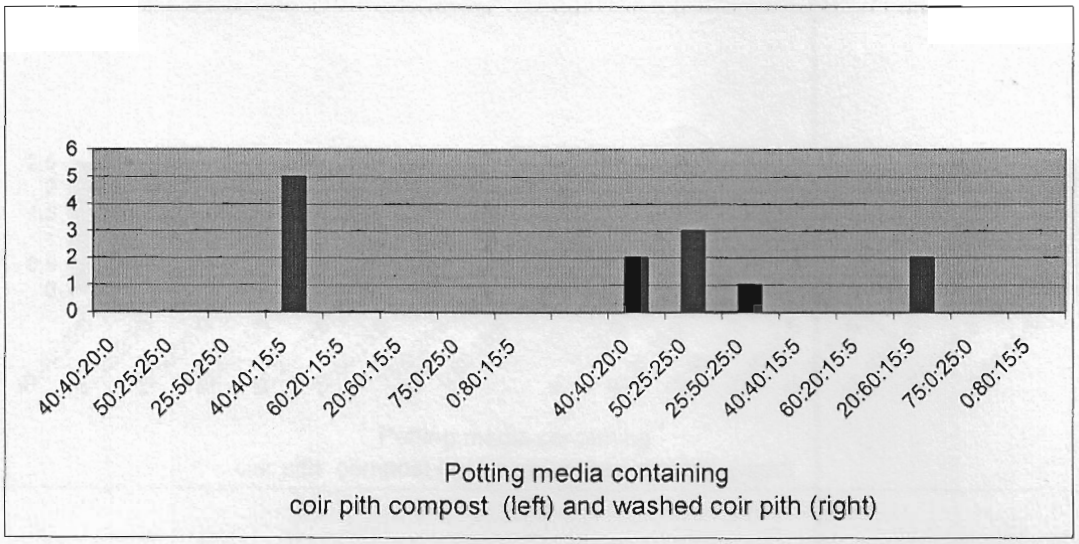


Fig. 6b. Nitrogen fixing bacterial population ($10^{-5}$ $g^{-1}$ oven dry basis) in different types of potting media

*Phosphate solubilisers:* Phosphate solubilising microorganisms (Table 7 and Figs.7a, 7b) were found only in 4 combinations of the potting media. Two phosphate solubilising bacterial colonies were found in potting media containing commercial coir pith (20:60:15:5) where as in the combinations with washed coir pith, 3 fungi and 1 bacterium were found solubilising phosphate.

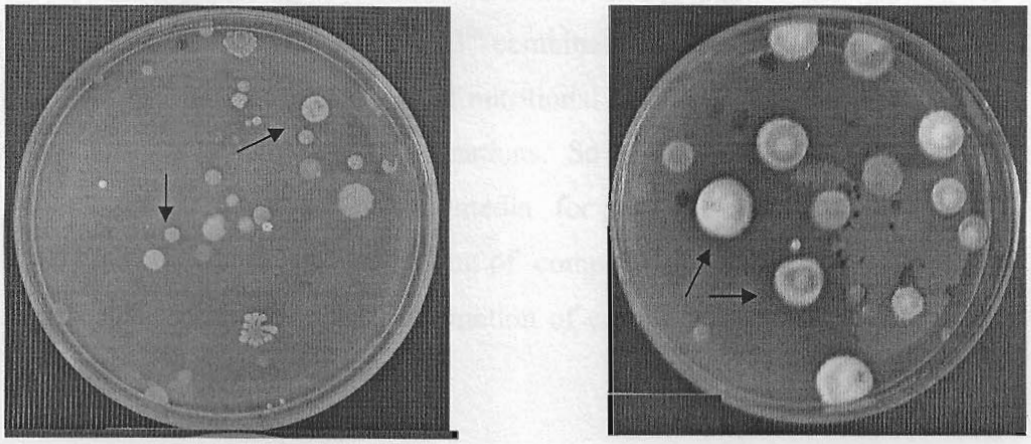

Fig. 7a. Phosphate solubilising bacteria (left) fungi (right)
(A clear zone is seen around the colony)

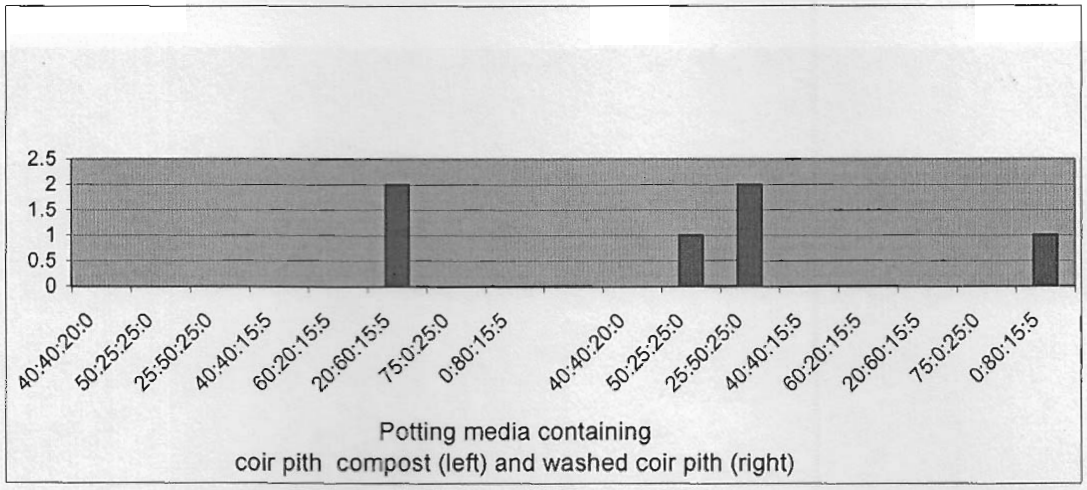


Fig. 7b. Population of phosphate solubilisers ($10^{-5}$ $g^{-1}$ oven dry basis) in different types of potting media

## 6. BEST POTTING MEDIA IN RELATION TO THE GROWTH AND NUTRITION OF TEAK SEEDLINGS

The results of the study in general revealed that mixing coir pith compost with mixed weed compost have changed the chemical condition of potting medium more favourable for healthy plant growth than the individual compost alone. Out of the sixteen treatments, the 4th, 5th, 12th and 13th combinations supported healthy growth of teak seedlings without the expression of nutritional disorders. But higher survival % was recorded only in 4th and 5th combinations. So these combinations of potting media were selected as the best potting media for growing teak seedlings in root trainers. Since the pH and nutrient content of composts and soil vary from site to site, slight modifications in the combination of composts may be done by the nursery managers if required.

The best potting media thus selected from this study were tried for raising teak seedlings by Kerala Forest Department at Central nursery, Chettikkulam during 2008 and the 5th combination was found successful for producing seedlings on large scale.

Fig. 8. Seedlings raised in the best potting media at Central nursery, Chettikkulam

## 7. CONCLUSION

The results of the study in general revealed that mixing coir pith compost with mixed weed compost have changed the chemical condition of potting medium more favourable for healthy plant growth than the individual compost alone. The combination of commercial coir pith compost, mixed weed compost, soil and sand in the proportion 40:40:15:5 and 60:20: 15:5 respectively were found successful for the healthy growth of teak seedlings in root trainers. The study also suggested to minimise the use of urea and rock phosphate during the preparation of mixed weed compost, if it is used as an ingredient in the potting mix in root trainers. The total number of bacteria and actinomycetes present in potting media containing commercial coir pith compost was more than that in media containing washed coir pith. In the case of fungal colonies, not much variation was found in both potting mixtures containing coir pith compost and washed coir pith. The beneficial microbes identified from the potting media were nitrogen fixers and phosphate solubilisers. But the number of these microbes present in different combinations was very low.

## 8. ACKNOWLEDGEMENTS

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