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Effects of growing media with bioinoculants on quality seedlings production of *Eucalyptus tereticornis* in nursery conditions

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ABSTRACT

Effect of coir pith and vermiculite based media inoculated with various bioinoculants PGPRs, PPFM, AM fungi along with vermicompost, farmyard manure, effluent compost, decomposed green manure, neem seed kernel cake, aegle seed cake etc., were critically examined at different mixing ratio as an integrated bio- nutrient management for the quality production of seedling of Eucalyptus tereticornis. It was demonstrated that some of the bioinoculant application could appreciably improve the germination behaviour (24 -100%) in our nursery experiments as the supplement of primary/micronutrients like protein, chlorophyll, Ca, N, Ph, Mg, K and organic carbon , and thus reducing the need for fertilizers. The inoculated seedlings shown better performance of biomass with reference to seedling survival, shoot length, collar diameter at 30- 60 days after application.

Key words: *Eucalyptus tereticornis*, bioinoculants,

INTRODUCTION

Production of high quality forest tree seedlings in nurseries is very important as far as tree nurseries and farmers are concerned for reversing the current degradation of natural forests, TOF, woodlands and scrublands in the tropics. Quality seedling production is the main objective of forest nursery but the slow growth of seedlings limits the high quality seedling production. Readiness of seed to germinate for further multiplication is much warranted and there is a need to optimize a growing media for high quality seedling production in tree nurseries. Slow growing nature of seedlings is the major limiting factor for successful seedling production in tree nurseries which can be enhanced by standardising the appropriate growing medium. For the production of plants in container, soilless growing medium is an ideal substitute to soil in which physical properties like aeration, drainage and water holding capacity are lacking. Nutrient value of the soilless growing media can be enriched by addition of specific nutrients and pure cultures of beneficial microbes like plant growth promoting microorganisms (PGPR) capable of enhancing the availability of nutrients for plant growth. In the present study, nutrient value of both coir pith and vermiculite based media were enriched by addition of farmyard manure, effluent compost, vermicompost, green manure, all composts, neem seed cake, aegle seed cake and all composts along with PGPR (*Azospirillum+Phosphobacterium*), AM fungi (*Glomus fasciculatum*) and Pink-pigmented facultative methylotrophic bacteria (PPFM). Eucalyptus is one of the important plantation crops which meets requirements of people, industries and has helped to reduce pressure on natural forests. More than 16 million hectares of eucalyptus is planted around the world for various purposes. In India, there is a high demand for the eucalyptus wood for various purposes [1], India ranks first in an area of 8.0 million ha, with a productivity of 146 t/ha [2]. Eucalyptus is also encountered by several severe problems in India and hence there is an increasing need for the modification/manipulation of the conventional process of nutrient managing, to effect in elevated nutrient concentration and also to reduce environmental pollution. *Eucalyptus* plantations have become preferred worldwide and attractive to other exotic trees because of its short-term visible

gains, there is a need to enhance seedling production for various plantation programmes. The quality of seedlings is very poor due to insufficiency of desired microorganisms and the rate of mineralization and nitrogen fixation is very low, as a result the quality of seedling is very poor. This problem can be overcome by providing suitable bioinoculants to improve the growth and nutrient uptake in *Eucalyptus* seedlings. There are few reports on the role of beneficial microbes mixed with different potting mixtures which could contribute significantly to the growth and defenses to insect pests of some of the tree species [3, 4]. The available information pertaining to this study is scanty; hence, the present study was undertaken to find out the compatibility of different bioinoculants and their augmentation effect on the production of quality seedlings suitable for out planting.

MATERIALS AND METHODS

Physico-chemical analysis of coir pith, and vermiculite base media treatments

The coir pith based medium treatments (T1-T6), vermiculite based medium treatments (T7-T12) and control (sand) were used for the study at 4:1. The coir pith and vermiculite based media treatments were analyzed for its physico-chemical characteristics such as pH, Electrical Conductivity (EC), available Nitrogen (N) [5], available Phosphorus (P) [5], available Potassium (K) [6] and micronutrients such as copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) following standard procedures of [7].

Seed germination and seedling growth

Seeds of *E. tereticornis* were sown in polythene bags filled with coir pith and vermiculite based medium (4:1) along with farmyard manure, effluent compost, vermicompost, green manure, all composts. For comparison, a set of plants were planted in sand as control. Bioinoculants such as PGPR (*Azospirillum &* Phosphobacterium) at a concentration of 5gm/ poly bag and AM fungi (*Glomus fasciculatum*) 10gm/ poly bag were also included in the above mixtures.

Experimental design

Twelve treatments including control, ten replication per treatment, ten ramets per replication and hence totally 100packs/ treatment were kept for experiment such as treatments T1-T6 consist of coir pith as a base medium (600 packs/6 treatments) and T7-T12 vermiculite as a base medium (600 packs/6 treatments) and control (sand) contains 100packs. Seeds of *E.tereticornis* were sown in all twelve treatments moisturized with water and placed in a germination chamber along with control. Periodical monitoring and observations of seed germination and seedling emergence were observed and recorded daily. Seedling emergence was noticed after one to two weeks, and found variation in germination percentage among treatments of different media and between the two base media.

Biometric observations

Biometric observations were taken at regular interval i.e., 30 and 60 days after inoculation (DAI) and the growth data such as shoot height, collar diameter, shoot and root dry weights were recorded after harvesting the seedlings. Height and growth of seedlings grown in various treatments including control (sand) were measured every week for two months after taking the initial data of the germinates in nursery bags. After the final height and diameter growth measurement, the seedlings were harvested to obtain total dry weight and it was determined by weighing of plants after being dried in an oven for 48 hours at 70^{o} C and one atmosphere of pressure. Duncan's multiple range test was used to compare growth data (shoot height, collar growth, and dry weight).

Seedling survival percentage was calculated using the formula;

$$\text{Seedling survival percentage} = \frac{\text{Number of seedlings survived per treatment}}{\text{Total number of seedlings transplanted per treatment}} \times 100$$

Statistical Analysis

The data analysis was performed statistically using one way ANOVA (Analysis of variance) with SPSS and treatment means were separated using Duncan's Multiple Range Test [8] and to evaluate the relationship between the nutrient content, total chlorophyll, protein, growth and biomass Pearson's bivariate correlation analysis (SPSS version 11.5) was used.

Metabolite quantification

Leaf samples collected from the seedling grown in different potting media (Coir pith and vermiculite based medium treatments T1-T12 and control) were subjected to metabolite quantification. Soluble protein was measured according to Lowry *et al*., (1951) [9], carbohydrate quantification using Sadasivam and Manickam (1996) [10], Phenol by McDonald *et al*., (2011) [11] and chlorophyll using Arnon (1947) [12].

RESULTS

Physico- chemical properties of coir pith

The physico-chemical properties of coir pith potting medium was investigated after grading it based on particle size ranging from 500µ - 2000µ in diameter (Table 1). Porosity, density and absorptivity of coir pith were inversely proportional to the size of particles. 500 µ size particles are having maximum absorptivity (72%) and on other end, coir pith having the highest particle size (2000µ) showed the lower absorptivity (46%). Water holding and retention capacities were higher in smaller particles. This implies that moisture retentivity and water holding capacity decreases with increased particle size. The pH, OC (%) and ash percentage increased from smaller particles (500µ) to bigger particles (2000 µ). Organic carbon percentage is getting increased from smaller graded particles (0.168%) when compared to higher graded particles (0.236%). The raw coir pith extract before grading was acidic (5.1) and after grading the pH was directly proportional to the particle size. The electrical conductivity was high (4.34 mS / cm) in smaller grade size (500µ) as compared to other sizes (1000µ -2000µ). Estimated ratio of N: P: K was low in bigger particles (2000 µ) 0.011:2.31:1.146 and high in other particle grades. Concentrations of calcium and magnesium ions are inversely proportional to each other with the average particle size of coir pith. Hence with significant physico chemical properties the graded coir pith of particle size 2000µ was selected for further treatments.

Table 1: Physico-chemical properties of graded coir pith

S.No	Parameters	Average particle size (µ)			
		500	1000	1500	2000
1	pH	6.3	6.5	6.7	6.8
2	EC (mS/cm)	4.34	4.12	3.83	3.17
3	Colour	Brownish yellow	Brownish yellow	Brownish yellow	Brownish yellow
4	Ash (%)	6.1	6.5	6.9	7.4
5	Temperature (°C)	28	28	28	28
6	Porosity (%)	81.57	74.89	69.23	65.81
7	Density (g/cc)	0.127	0.091	0.083	0.076
8	Absorptivity (%)	72.0	62.0	55.0	46.0
9	Nitrogen (mg/g)	0.013	0.010	0.010	0.011
10	Phosphorous (mg/g)	2.65	2.57	2.49	2.31
11	Potassium (mg/g)	1.386	1.334	1.217	1.146
12	Calcium (mg/g)	42	35	31	28
13	Magnesium (mg/g)	0.4	0.8	1.2	1.4
14	Organic carbon (%)	0.168	0.185	0.216	0.236

Physico- chemical properties of coir pith and vermiculite based medium treatments

The potting media has to be enriched with nutrients and amended its physico chemical properties in order to make it as suitable growing media for the production of quality seedlings in nursery. Graded coir pith was homogenized and optimized to have a neutral pH and optimal electrical conductivity by subjecting to effective treatments systematically. The coir pith and vermiculite base medium treatments were acidic in nature except the treatment T6 which was neutral and T2 which was slightly alkaline. The electrical conductivity of the raw coir pith was measured high (3.17 to 4.34 mS/cm), hence coir pith was washed continuously with tap water for 3-5 days which resulted in the decrease in electrical conductivity (>1mS/cm**)**. The micro and macro nutrient concentration varied among treatments (Table 2).

Germination behaviour of plant samples

Slow growing nature of seedlings is the major limiting factor for successful seedling production in tree nurseries which can be enhanced by standardising the appropriate growing medium. Over all coir pith based medium treatment T6 (66%) showed higher germination percentage followed by T5 (64%) and the vermiculite based medium treatment T12 (63%). Though high germination percentage was recorded in coir pith based potting media T5 and T6, over all better seed germination behaviour was noticed in vermiculite based potting media as compared to coir pith base potting media (Table 3). The germination percentage of the seeds were increased (41 -63%) in all vermiculite based medium treatments (T7-T12) than control (41%) due to the amendments made in the potting medium through co-composting with biomanures and bioinoculants (Fig 1). The co-composting of coir pith with effluent compost, vermicompost and green manure did not enhance the ability of eucalyptus seed germination capacity (30 -37%), except T5 and T6 (64 % and 66 %).

Table 2. Physico- chemical properties of coir pith base and vermiculite medium treatments

Coir pith medium treatments						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
pH	6.7	7.3	6.2	6.4	6.9	7.0
EC(mS/cm)	0.72	0.92	0.71	0.68	0.90	0.95
Colour	Brownish dark yellow	Brownish dark yellow	Brownish grey	Brownish semi black	Brownish semi black	Brownish semi black
Ash%	6.7	6.4	6.8	6.0	6.4	6.7
Temperature ºC	28	29	27	26	27	28
Nitrogen (mg/g)	2.8	3.0	5.0	4.0	1.8	5.0
Phosphorous (mg/g)	0.004	0.005	0.004	0.004	0.005	0.005
Potassium (mg/g)	4.0	4.0	1.0	3.0	2.0	4.0
Calcium (mg/g)	40	44	52	48	56	52
Magnesium (mg/g)	1.2	0.5	0.5	1.0	1.0	1.0
Organic carbon (%)	2.2	4.6	2.7	0.6	2.3	0.5
vermiculite base medium treatments						
Parameters	**T7**	**T8**	**T9**	**T10**	**T11**	**T12**
pH	6.0	6.3	6.1	6.6	6.8	6.3
EC	0.32	0.36	0.39	0.34	0.40	0.54
Colour	Brown/ yellow	Brown/ yellow	Brown/ yellow	Brown/ Yellow	Brown/ yellow	Brown/ yellow
Ash%	nil	nil	nil	nil	nil	nil
Temperature ºC	27	28	26	28	29	29
Nitrogen (mg/g)	3.9	3.7	4.6	5.8	5.0	5.0
Phosphorous (mg/g)	0.005	0.004	0.004	0.004	0.005	0.004
Potassium (mg/g)	4.7	4.0	4.2	4.0	3.0	3.0
Calcium (mg/g)	48	56	60	64	56	64
Magnesium (mg/g)	2.0	2.0	3.6	4.1	5.0	5.0
Organic carbon %	0.5	0.2	2.0	0.8	0.8	8.6

Note: *T1-Coir pith+FYM, T2-Coir pith+effluent compost, T3- Coir pith+vermicompost, T4- Coir pith+green manure, T5-Coir pith+all composts, T6- Coir pith+all composts+ PGPR+ PPFM +AM fungi+ NSC+ASC. T7-Vermiculite+Fym, T8-Vermiculite+effluent compost, T9-Vermiculite+ vermicompost, T10- Vermiculite+green manure, T11- Vermiculite+all composts, T12- Vermiculite+ all composts+ PGPR+ PPFM +AM fungi+ NSC+ASC.*

Table 3. Seed germination study of *Eucalyptus tereticornis*

Treatments	**Coir pith base medium**		**Treatments**	**Vermiculite base medium**	
	No. of seedlings emerged	**Germination Percentage (%)**		**No. of seedlings emerged**	**Germination Percentage (%)**
Control	41	41	Control	41	41
T1	30	30	T7	54	54
T2	37	37	T8	41	41
T3	36	36	T9	42	42
T4	33	33	T10	45	45
T5	64	64	T11	57	57
T6	**66**	**66**	**T12**	**63**	**63**

Note: *T1-Coir pith+FYM, T2-Coir pith+effluent compost, T3- Coir pith+vermicompost, T4- Coir pith+green manure, T5- Coir pith+all composts, T6- Coir pith+ all composts+ PGPR+ PPFM +AM fungi+NSC+ASC, T7-Vermiculite+FYM, T8-Vermiculite+effluent compost, T9-Vermiculite+ vermicompost, T10- Vermiculite+green manure, T11- Vermiculite+all composts, T12- Vermiculite+ all composts+ PGPR+NSC+ASC+PPFM + AM fungi, Control-sand.*

From the analysis of growth data observed that the co composting of coir pith and vermiculite based media with farmyard manure, vermicompost, effluent compost, green manure and bioinoculants were found to be the most effective in increasing the growth and biomass of seedlings (Table 4). Significant difference was observed between the two base media; shoot attained a maximum height of 46.12cm with collar diameter of 4.46mm in coir pith base potting medium T6, whereas in case of vermiculite based medium T12 showed only 24.75 cm shoot height with 3.78 mm collar diameter after 60 days. Better growth performance was noticed in all growing media than control after 60 days even though in few treatments T3, T4, T5, T9 and T11, the seedling growth was lesser as compared to control in 30 days. The seedlings grown in the treatments T8 (8.75 cm) and T10 (10.97%) showed lesser performance than control even after 60 days. Collar diameter was lesser than control in all the potting media except T6 (4.46mm) and T12 (3.78mm). Over all significant increase in seedling shoot height was recorded in all treatments except T8 and T10. Quantification of biomass of the seedlings grown in coir pith based medium treatments T2, T3, T4 and T5 (6.97/2.38g/plant; 6.84/2.33g/plant; 6.24/2.27g/plant and 6.48/2.45g/plant respectively) showed not much significant difference between them and recorded low shoot and root dry weights as compared to treatments T1 and T6. Overall biomass study revealed that seedlings grown in coir pith based medium treatment T6 had high shoot and root dry

weights. The treatments T7-T11 did not shown any significant difference in biomass, where it was observed that the shoot and root biomass of treatment T6 was maximum over the treatment T12.

Fig 1. *Eucalyptus tereticornis* seed germination in different potting mixture

Table 4. Study of shoot length, collar diameter and biomass of *Eucalyptus tereticornis* in coir pith and vermiculite base medium

Treatments	Shoot length (cm)			Collar diameter (mm)			Biomass	
							Dry weight (g/plant)	
							Shoot	Root
	Initial	30days	60days	Initial	30days	60days	60days	60days
Control	7.47a	11.61b	11.89a	0.1ab	1.25bc	3.20e	4.78a	2.69b
T1	8.97b	13.28bc	22.01c	1.07ab	1.73d	2.72d	7.39d	2.41a
T2	7.41b	15.98c	31.63d	0.08a	0.81a	1.18a	6.97c	2.38a
T3	6.95a	9.95a	16.97b	1.12b	1.2bc	2.13c	6.84c	2.33a
T4	7.11a	10.02a	16.74b	1.04ab	1.18b	1.64b	6.24b	2.27a
T5	6.93a	10.95ab	32.03d	0.87a	1.11ab	1.52ab	6.48b	2.45a
T6	**10.0c**	**26.42d**	**46.12e**	**1.23b**	**2.75e**	**4.46e**	**7.93e**	**2.99c**
T7	6.6b	12.63b	19.14c	0.86b	1.14b	1.69bc	7.06de	2.37ab
T8	3.89a	6.0a	8.75a	0.49a	0.79a	1.3a	6.65d	2.37ab
T9	3.56a	5.62a	14.22b	0.41a	0.72a	1.55b	6.53d	2.32a
T10	3.57a	6.41a	10.97a	0.45a	0.76a	1.34a	5.95b	2.29a
T11	3.83a	5.9a	15.9b	0.51a	0.78a	1.38a	6.193c	2.38ab
T12	**7.59c**	**14.66c**	**24.75d**	**1.85d**	**2.35d**	**3.78d**	**7.65e**	**2.641b**

Note: *Means followed by a common letter(s) in the same column are not significantly different at 5% level by DMRT (Dungan Multiple Range Test). T1-Coir pith+FYM, T2-Coir pith+effluent compost, T3- Coir pith+vermicompost, T4- Coir pith+green manure, T5- Coir pith+all composts, T6- Coir pith+ all composts+ PGPR+ PPFM +AM fungi+ NSC+ASC, T7-Vermiculite+Fym, T8-Vermiculite+effluent compost, T9-Vermiculite+vermicompost, T10- Vermiculite+green manure, T11-Vermiculite+all composts, T12- Vermiculite+all composts+ PGPR+ PPFM +AM fungi+ NSC+ASC, Control-sand.*

Phytochemical and nutrient analysis in seedlings

Based on the growth performance and biomass data, the seedlings grown in the potting media T6 (coir pith) and T12 (vermiculite) were selected for biochemical analysis. Higher concentrations of protein (1.59mg/g), carbohydrate (1.78mg/g), chlorophyll (1.41mg/g), N (0.22mg/g), P (0.76mg/g), K (3.98mg/g) and phenols (4.73mg/g) was estimated in the *E. tereticornis* leaves of the seedlings grown in the coir pith based potting media T6, when compared to vermiculite based medium treatment (T12) and control (Fig 2). In the seedlings grown in vermiculite base potting medium except phosphorous and potassium all other phytochemical quantities were increased than control. Based on the results it was found that coir pith based medium of treatment T6 (supplemented with all composts, PGPR and AM fungi) was chosen as the best treatment for the growth of *E. tereticornis.*

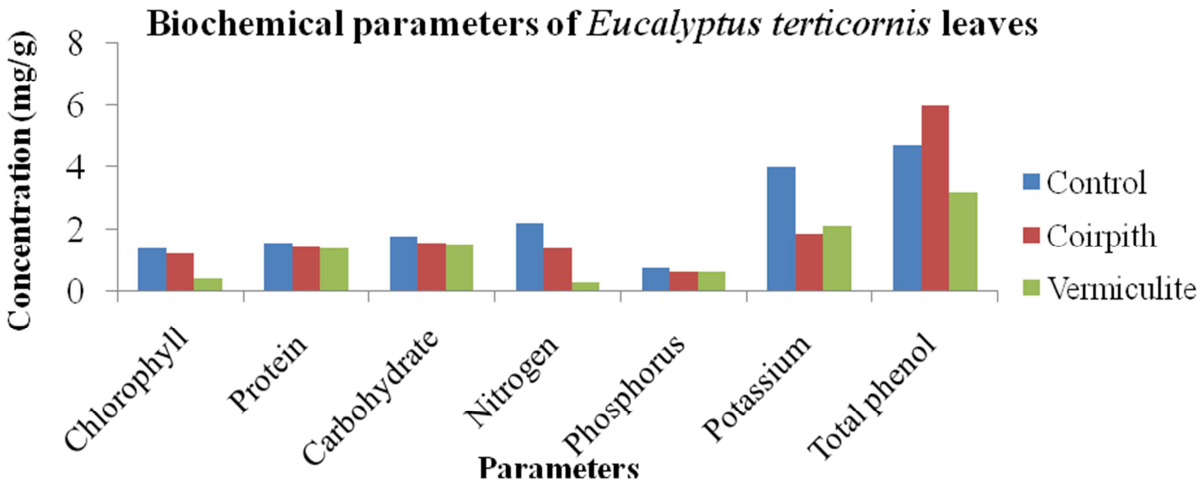

Fig 2. Biochemical analysis of *E.tereticornis* leaves

DISCUSSION

Eucalyptus plantations have become preferred worldwide and attractive to other exotic trees because of its short-term visible gains, hence need to enhance seedling production. Mafia *et al*. (2009) [13] reported that PGPR promoted germinating capacity of *Eucalyptus* seeds. In the present study, seeds of *E. tereticornis* showed high germination percentage in all vermiculite based potting medium treated with bioinoculants, farmyard manure, effluent compost, vermicompost and green manure (T7 to T12) than control. Green manuring can improve soil physical, chemical and biological properties leading to beneficial effects on rice or wheat crops production [14]. In case of coir pith base potting medium, T1, T2, T3 & T4 treatments had low germination percentage (30% - 37%) as compared to control (40%). The co-composting of coir pith with effluent compost, vermicompost and green manure did not enhance the ability of eucalyptus seed germination capacity, and poor germination percentage was noticed than that of control. This might be due to the fact that the composting of coir pith with farmyard manure, effluent compost, vermicompost and green manure have not much altered the nutrient supply and water holding capacity of the coir pith which was not enough to accelerate the seed germination. Composting process of farmyard manure in vermiculite based medium showed significant seedling emergence (54%) than coir pith base medium (30%), same effect was observed with effluent compost, vermicompost and green manure. Inclusions of vermicompost in potting medium reduce/eliminate addition of trace elements like potassium, sulphur and phosphorous for planting stock establishment [15]. Coir pith composted with effluent compost, vermicompost and green manure showed low seedling emergence percentage than control. Coir pith based medium fermented with all composts (T5) and all composts along with bioinoculants (T6) performed better than vermiculite base medium treated with same. Significant difference in seed germination was found between composts due to efficiency of water holding capacity of two base media and availability of water to the plants during the growth phase. Soil ameliorating practice is rising in recent years because of high possibility of environmental pollution, chemical fertilizers, and need for the production of healthy plants by nursery growers.

Choosing the correct type of potting medium for seed germination and seedling growth is an essential and correct step to produce good quality planting stock in nursery conditions. Growth performances of *E. tereticornis* seedlings in all treatments of coir pith based growing medium showed increase in shoot height where as collar diameter was lesser than that of control except treatment T6. Eucalyptus seedlings showed greater plant growth in media amended with vermicompost compared to the control media [16]. To raise *E. grandis* seedling a fertilized potting mixture was adequate and addition of unleached vermicompost to a composted pine bark based growing media was conductive to survival and good growth [17]. Vermicompost retains nutrients for long time and deliver the required amount of macro and micronutrients including the essential NKP (nitrogen, potassium & phosphorus) to plants in shorter time and the ‘humic acid’ in vermicompost stimulate plant growth even in small amount [18]. Increase in shoot length was recorded in 60days in all treatments of coir pith potting medium, though treatments T3, T4 and T5 showed shoot height less than control in 30 days. The optimum proportion of the organic ingredient (compost 40%) in added to the potting medium resulted in the best growth of *E. tereticornis* seedlings [19]. Data recorded on 30days revealed that shoot height was greater in coir pith base medium mixed with farmyard manure (T1), effluent compost (T2) and all composts along with bioinoculants (T6) as compared to control. Improved growth of seedlings using coconut husk (decomposed coir pith) as an organic potting medium ingredient has been reported in *E. tereticornis* [20]. Phosphobacterium inoculated *E. camaldulensis* seedlings recorded increased growth and P uptake in relation to

uninoculated control plants in and combined application of *Azotobacter* and Phosphobacterium increased 20.2% in height, 33.7% in collar diameter, 34.6% in fresh weight and 44% in dry weight over control [21]. Co-inoculation of endomycorrhizal fungi along with other beneficial microbes on establishment and growth of *Eucalyptus saligna* seedlings showed maximum increase in seedling height [22]. Collar diameter was lesser than control in all treatments of coir pith base medium except in treatment T6. Growth performances of *E. tereticornis* seedlings in vermiculite base medium treatments showed that shoot height after 60 days reached a maximum in T12 treatment. Inoculation of Phosphobacterium in an unsterilized soil improved collar diameter, fresh weight and dry weight compared to uninoculated control in *E. camaldulensis* seedlings [21]. Significant difference was observed between the two base media. *E. tereticornis* grown in highly alkali soil (pH 10.5) when amended with pressmud one of the major sugar factory wastes could perform very well [23]. Pressmud contains N (1.2 %), P_2O_2 (3.82 %), K_2O (1.42 %) and CaO (11.1 %) [24]. Eucalyptus grown in a mixture of city refuse vermicompost (40%) and garden soil (60%) produced larger biomass independent of nutrient supply [21]. Selection of effective potting mixture for the quick plant growth and biomass production is possible by understanding the metabolic pathways of complex nutrients in the growing medium influenced by bioinoculants together with water retention capacity of coir pith which gained importance after several combination studies and could made nutrients easily available for the plant and promotes growth and biomass. Srinivas *et al*. (1988) [25] studied the growth responses of *E.tereticornis* inoculated with AM fungi (*Glomus fasciculatum, G. epigaeum* and *Acaulospora morrowiae*) and observed that inoculation of AM fungi increased biomass, N, P and K uptake of the seedlings. Eucalyptus seedlings' stem dry weight was increased up to 49% compared to uninoculated control plants twenty weeks after mycorrhizal inoculation [26]. *E. tereticornis* seedlings grown in a soil amended with mixed indigenous AM fungi showed maximum dry matter production and had higher shoot P and N contents due to addition of optimal phosphorus to soil required for plant growth [27, 28]. The inoculation of bioinoculants either singly or in combination on *E. tereticornis* resulted in high biomass built up over control [29].

Nutrients were quantified higher in both the media than that of control in the case of *E. tereticornis* except total phenol which was high in vermiculite base medium. The maximum chlorophyll and protein contents recorded in the seedlings inoculated with *Azospirillum* were attributed to the greater supply of nitrogen to growing tissues [30]. Chlorophyll content was three times more in vermiculite based medium and 3.5 times in coir pith based medium grown seedlings, nitrogen concentration was seven fold increase in coir pith base medium and 4.5 fold in vermiculite based medium grown seedlings, which may be responsible for increase in plant height four times in coir pith based medium and two times in vermiculite based medium than that of control. High leaf nitrogen content facilitates the plant with more of nitrogen which depicts high rates of photosynthesis and high tree productivity and excessive amount of N reduces tree productivity [31]. *E. tereticornis* seedlings grown in a soil amended with mixed indigenous AM fungi showed higher shoot P and N contents [27].

CONCLUSION

Soil ameliorating practice is increasing in recent years because of high cost of chemical fertilizers, increased risk of environmental pollution, and need for the production of healthy plants by nursery growers. Irrespective of the potting media used for the present study 100 % survival rate was recorded in all the potting media (coir pith and vermiculite as base media) including control. The potting media has not only provided growing space, but also act as nutrient source for plants. The nutrient amendments made in the potting media through supplementing different composts and bioinoculants (PGPR, PPFM, neem seed cake, aegle seed cake and AM fungi) brings significant enrichment in nutrient composition of potting media, enhancement in seed germination rate, seedling growth performance and bioactive compounds of the seedlings which ultimately produced healthy seedlings suitable for out planting.

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