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Comparative Evaluation of Raw Coir Pith and Nutritionally Enriched Coir Pith on Germination of Commercially Important Tropical Tree Seeds

N. Senthilkumar*, R. Sumathi, D. Suresh Babu and A. C. Surya Prabha

ICFRE- Institute of Forest Genetics and Tree Breeding, R.S. Puram, Coimbatore - 641002, India

**Corresponding author*

Abstract

Quality seedling production is the main goal of forest nurseries, but slow seedling growth limits high seedling production. The readiness of seeds to germinate for further propagation is very reasonable, and there is a need to optimize the growing medium for high-quality seedling production in nurseries. Slow seedling growth is the main limiting factor for successful seedling production in nurseries, which can be improved by standardizing a suitable growing substrate. However, supplying farmers with quality planting material is a major challenge due to micro and macro nutrient deficiencies, insect pests and disease management. For growing plants in containers, soilless growing media is an ideal substitute for soil that lacks physical properties such as aeration, drainage and water-holding capacity, as there is a huge demand for sand and soil, which are the main components of conventional potting mixes. Municipal waste i.e. coconut fibre biomass residues, flower market waste and vegetable market waste constitute the major part of the waste available in and around Coimbatore district (India) which requires attention in terms of solid waste management. To solve these problems, a nutrient-enriched "Tree-Rich Biobooster" based on decomposed coir waste along with flower and plant waste compost was developed as an instant potting mix to produce quality planting material.

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Keywords

Coir pith, flower and vegetable waste, Tree Rich Biobooster, growth media, potting media.

Introduction

Currently, in India, urbanization, industrialization, uncontrolled growth in population leads to increase in waste materials which has become a major threat to the environmental issue (Awasthi *et al.,* 2014). Flower and vegetable waste is dumped in the respective markets, all leading to outbreaks of local diseases as the waste attracts insects. Some flower traders in flower markets also threw flower waste on the street (Insam *et al.,* 1996). Proper disposal of flower waste is essential as it poses a serious threat to the environment during the rainy season due to breeding of mosquitoes and flies. Leachate production from flower litter eventually leaches into water sources and causes health problems (Atallah *et al.,* 1995). Proper waste management has become a major challenge in many countries to avoid all such issues as a proper waste management strategy is very crucial. Composting has become a viable option for safe hygienic and cost effective disposal of waste. It is a well-known and widely used method for converting organic waste into nutrient-rich soil products. The use of agricultural waste as fertilizer and growing media avoids environmental pollution and provides organic healthy food. Several studies have reported that fertilizers increase the growth efficiency of vegetable crops due to

increased supply of plant nutrients (K, P, Ca, NH4, NO3) (Agegnehu *et al.,* 2016; Bass *et al.,* 2016; Karami *et al.,* 2011). Flower waste (500Kg) and vegetable waste (500 Kg) were collected from flower and vegetable markets respectively and composted at ICFRE-Institute of Forest Genetics and Tree Breeding, Coimbatore (India). This waste was composted aerobically. Coir pith based potting medium was added with appropriate amount of compost and used as eco-friendly potting medium for raising nursery for production of healthy seedlings.

Materials and Methods

Raw materials

One ton of coir pith (coconut fiber waste) was collected from Pollachi, Coimbatore District, (India). It is situated between 10° 39' 26.1864" N and 77° 0' 38.3976" E at an altitude of 293m ASL. ~500 kg each of flower and vegetable waste was collected from flower market and vegetable market in Coimbatore (India) respectively. Coimbatore is situated between 11° 0' 16.4016" N and 76° 57' 41.8752" E at an altitude of 427m ASL.

Composting

The collected coir pith was washed with running water for two weeks with two days interval and sun dried for a week. Further it was transferred into 1 ton capacity cement tank size of 1.2mx1.2x0.9m (Length x breadth x height) and 100 kgs of farm yard manure was added and regular watering was done at 3 days interval for 15 days. After that the partially composed materials were turned up and down at alternate days with regular watering. After a month the composted material was sieved and sun dried for a week to reduce the moisture to 12%>. The flower and vegetable wastes are also composted by aforementioned method.

Development of Tree Rich Biobooster

The Tree Rich biobooster was developed using Coir pith, flower and vegetable composts along with Farm yard Manure at the ratio of 2:0.5:0.5:1resepctively. The physic chemical and The “Tree Rich Biobooster” (TRB), a well-nourished comprehensive potting mix alternate to conventional potting mixture (Sand:Soil:Farm Yard Manure) developed for production of healthy saplings potentially results in reduction of fertilizers, irrigation, decreases nursery cost and enhanced the germination percentage, growth performances and yield of crops.

Physico-chemical properties of coir pith & Tree Rich Biobooster

The physico-chemical characteristics such as pH, Electrical Conductivity (EC), available Nitrogen (N) (Jackson, 1958), available Phosphorus (P) (Jackson, 1958), available Potassium (K) (Sankaram, 1966) and micronutrients such as copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) (Lindsay and Norvell, 1978) were measured for the raw coir pith as well as composted coir pith, flower waste compost and vegetable waste compost using standard procedures.

Evaluation Tree Rich Biobooster

To evaluate the efficiency of Tree Rich Biobooster, germination percentage of seeds such as *Simarouba glauca*, *Casuarina equisetifolia*, and *Eucalyptus tereticornis* were tested and the growth promoting efficiency was also tested using Tree Rich Biobooster under nursery conditions. Seed germination tests were conducted on seed bed. After one month seedlings were transferred to polybags containing Tree Rich Biobooster. Growth parameters such as shoot length and collar diameter at initial stage, after one month and two months were taken and data was analysed statistically.

Results and Discussion

The current boom in fertilizer prices, the growing preferences for organically cultivated farm produce and farm energy requirements has demanded the development of a programme for organic waste recycling in agriculture. Coir pith is a multipurpose potting medium, an ideal substitute responsible for good aeration and retaining water for longer duration around the roots of plants and an excellent soil conditioner. It also provides new opportunities for hydroponic growers, potting mix suppliers, seedling nursery operators, home gardens, green houses and other farming communities. Coir pith or coir dust is a major byproduct of coir fiber extraction industries pose the danger of pollution and health hazard (Reghuvaran *et al.,* 2010) and is dumped as agricultural waste and accumulates as a waste product as heaps of course and fine dust (Ghosh *et al.,* 2007). Coir pith improves the water holding capacity. As it contains all plant nutrient elements it can provide a supplemental effect along with inorganic fertilizers. Coir pith waste is available in plenty. It is easily transportable, organic, eco-friendly and of low cost. Apart from the above, use of coir pith in large scale will also reduce the accumulation of the coir waste in coir belt areas creating

environmental problems. Hence, coir pith waste has been processed, composted and utilised for the production of organic potting mixture which is alternate to conventional potting media (Sand, soil and FYM). Composted coir pith is excellent organic manure for indoor plants as well as for horticulture crops. Evans *et al.,* (1996) reported that the chemical and physical properties of Coconut coir dust (CD) from numerous sources and reported that properties were generally within acceptable ranges. CD is widely used, alone or mixed with other materials, as an alternative growing medium for soilless cultivation of vegetables, cut flowers and potted plants as it evidenced growth performances similar to that of peat. Coir can also be used as rooting medium for cuttings under mist because of the presence of root-promoting substances. As a smart solution for waste disposal problems and the rising interest in waste recycling has resulted in a greater use of organic materials and composts as potting media for raising quality seedling (Fascella, 2015).

Physico-chemical properties of coir pith and Tree Rich Biobooster

The potting medium has to be enriched with nutrients and its physicochemical properties need to be improved to make it a suitable nutrient rich growing medium for the production of quality seedlings in the nursery. The graded coir pith was homogenized and systematically subjected to effective treatments optimized to obtain neutral pH and optimal electrical conductivity. Physico-chemical characteristics like pH, electrical conductivity (EC), available nitrogen (N), available phosphorus (P), available potassium (K) and micronutrients like copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) were measured for raw coir back as well as manure compost, flower waste compost and vegetable waste compost using standard procedures and the results are tabulated in Tables 1 and 2.

The pH of the raw coir pith was observed to be acidic whereas treated coir pith showed neutral pH and the electrical conductivity of the raw coir pith (4.12 mS/cm) was brought down to 0.95 (mS/cm) through composting process optimal for making potting media for quality planting stock production of forestry and vegetable crops. Processed compost generally has a pH range between 6 and 8 and if the pH reduces below 6.0 results in the microorganisms mortality and slow down the decomposition process. If the pH reaches 9, nitrogen is converted to ammonia and becomes unavailable to organisms. Evans *et al.,* (1996) reported that physicochemical properties of coir waste depends upon the fibre quantity and hence increase in fibre is generally associated with increased porosity, decreased bulk density and water holding capacity.

Macro and micro nutrients analysis

The nutrients are the basic components required not only for plant growth but also to stabilize the plant during drought and diseases. Plants get these essential components (macro and micro nutrients) from their growth media like soil/potting media. Nutrients are mobile within the plant and its deficiency causes various problems in plants. Compost when mixed with potting media assure the more nutrient availability to the plant and many studies emphasized the importance of the nutrients Na, P, K and Ca to protect the plant from diseases, pests, drought and cold (Debosz *et al.,* 2002; Tsai *et al.,* 2007). When compost is mixed with soil it increases soil acidification and makes more nutrients available to the plant. The higher potassium (K) content of the coir pith indicates the importance of this material and possibility of utilizing this as a supplier of K to the crops which makes the plant drought tolerant. Total nitrogen content was comparatively high in flower waste followed by FYM and vegetable waste. Nitrogen content was almost tripled in treated coir pith than the raw material. Not much variation was noticed in case of phosphorous, calcium, magnesium copper and organic carbon content in all the materials studied. Iron content was doubled while processing the coir pith (Table 2). Iron is an ingredient of several enzymes, some pigments and helps in chlorophyll synthesis, to carry important elements through a plant's circulatory system and energy production within the plant.

Treated coir pith had 206 ppm of iron whereas raw coir pith had only 97 ppm. Flower waste and FYM reported to have 230 and 232 ppm of iron content and the product reported to have 247 ppm of iron. The product TRB the composted mixture of all the materials in appropriate proportion reported to have all macro and micro nutrient enhancement in 2-3 folds than individual material.

Considering nitrogen content the most imperative element that encourages proper growth and development of plants, reported as 4.7 % in the product TRB where as in individual material flower waste showed the maximum of 3.12 %.The micro nutrient manganese was enhanced from 21 ppm in raw coir pith to 280 in the product TRB which showed that the massive nutrient enrichment in the product than the raw material.

Table.1 Physico-chemical properties of coir pith

Parameters	Raw coir pith	Treated coir pith
pH	6.5	7.0
EC (mS/cm)	4.12	0.95
Colour	Brownish yellow	Brownish black
Ash (%)	6.5	6.7
Temperature (°C)	28	28

Table.2 Macro and micro nutrient analysis

Nutrients	RC	TC	VW	FW	FYM	TRB
Total Nitrogen (%)	0.784	1.96	2.008	3.12	2.134	4.70
Total Phosphorus (%)	2.13	2.32	2.17	3.11	2.30	3.96
Total Potassium (%)	1.04	1.64	2.26	1.41	2.51	3.50
Total Calcium (%)	0.36	0.44	0.08	0.52	0.28	0.72
Total Magnesium (%)	0.10	0.14	0.32	0.24	0.33	0.39
Copper (ppm)	9	13	12	12	13	19
Zinc (ppm)	60	57	84	93	68	97
Manganese (ppm)	21	63	92	68	135	280
Iron (ppm)	97	206	117	230	232	247
Organic Carbon (%)	0.5	0.52	0.58	0.62	0.58	0.73

RC= Raw Coir pith; TC= Treated Coir pith; VW= Vegetable waste; FW= Flower Waste; ; FYM= Farmyard manure; TRB=Tree rich biobooster.

Table.3 Germination of seeds of tropical tree species in Tree Rich Biobooster

Germination of seeds of tree species									
S. No.	Tree Species	Control				Tree Rich Biobooster			
		1st week	2nd week	3rd week	Total	1st week	2nd week	3rd week	Total
1	Casuarina 2gms (1400 seeds)	60 (4.28%)	80 (5.71%)	90 (6.42%)	230 (16.42%)	120 (8.57%)	180 (12.85%)	200 (14.28%)	500 (35.71%)
2	Eucalyptus 2gm (696 seeds)	60 (8.67%)	90 (12.93%)	110 (15.8%)	260 (37.35%)	80 (11.49%)	100 (7.14%)	120 (9.28%)	300 (43.10%)
3	Simarouba 61.19gms (63 seeds)	5 (7.93%)	9 (14.28%)	12 (19.04%)	26 (41.26%)	8 (12.69%)	12 (19.04%)	15 (23.8%)	35(55.5%)

Table.4 Growth performance of tree species in coir pith in comparison with conventional potting media

Duration	Height (cm)					
	Casuarina		Eucalyptus		Simarouba	
	Control	Coir pith	Control	Coir pith	Control	Coir pith
30 Days	6.21	7.94	2.93	4.104	7.82	8.44
60 Days	7.11	8.2	3.42	5.006	10.3	12.88
90 Days	7.85	8.91	6.298	6.976	14.1	18.92

Considerably high organic carbon percentage was reported in the product TRB 0.73 % followed by 0.67 % in weed waste and 0.62 % in flower waste and only 0.5 % in raw coir pith and 0.52 % in treated coir pith (Table 2). Caravaca *et al.,* (2003) reported that compost as a good source of Nitrogen (N), Phosphorus (P), Potassium (K) and micronutrients (Jimenez and Garcia, 1989), increase the organic matter, micro and macronutrients, physico-chemical properties of the potting media.

Germination studies

Germination and emergence are a make it or break it moment for seedlings and seed wait to germinate until it met its requirements like water, optimum temperature and a suitable growing place/media. Media composition influences the seed germination percentage and quality of the seedlings (Wilson *et al.,* 2001). Potting media plays a key role in quality plant production and it satisfies the requirement for the production of healthy seedling which will survive better after field planting and commence growth quickly. Testing the nursery growing media through seedling growth trial is always recommended to evaluate the efficacy of potting media and additional nutrients required for seedling emergence.

Tree species

Production of healthy and quality planting stock are highly important to meet the plantation target by the State Forest Departments, Wood based industries and Tree growers. Nursery is a very important place upon which the success or failure of establishment of large scale plantation depends. Nurseries, therefore, should be able to produce high quality seedlings that hold optimal level of mineral nutrients when deliver for out planting. A good potting mixture should have constant balance of equally firm and absorbent particle to prop up good aeration and drainage but also be capable of retaining water and nutrients. Amendment of nursery potting media with nutrient-containing compounds to raise seedlings to transplant is a main determinant aspect to set up a successful planting stock for tree breeding programme. 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. Hence in the present study, seeds of tree species viz., Eucalyptus, Casuarina and Simarouba were evaluated for its germination performance (table 3) in treated coir pith media in comparison with conventional potting mixture (sand:soil:FYM) and observed increase in germination percentage ie. 43% in Eucalyptus, 36 % in Casuarina and 56 % in Simarouba and 5 to 20% increment of growth in all the tree crops. Though coir pith is low in nutrient when mixed with vermicompost provides a better medium for plant establishment (Campos Mota *et al.,* 2009; Abirami *et al.,* 2010).

Growth performance of tree crops

The effectiveness of treated coir pith in enhancing the growth of selected economically important tree species viz., casuarina, eucalyptus and cimaroba in the nursery was tested against its effectiveness in conventional potting medium (control). The growth performance of seedlings was recorded in coir back based medium. up to ninety days with respect to shoot height (Table 4). Cassava seeds germinated in treated coir pith potting media attained a maximum height of 7.94 cm compared to 6.21 cm in control, Eucalyptus 7.82 cm and 2.93 cm and Simarouba 8.44 and 7.82 cm in coir pith and control at 30 days. It was observed that casuarina showed 27.9% seed growth, Eucalyptus 40% and Simarouba 7.9% at 30 days and casuarina (13%), Eucalyptus (10%) did not show much growth at 90 days. Except Simarouba which shows a 34% increase in height. Germination and growth performance of plant seedlings were enhanced in soil-less, eco-friendly, low-cost and easily transportable coir pith media as compared to conventional potting media (high cost and lack of availability of sand). Application of vermicompost in mixture with cocopeat improved the physical condition and nutritional parameters of the media (Sahni *et al.,* 2008).

Conclusion

Plantation forestry has tremendous scope for rural livelihood improvement and wood-based industries. However, supply of quality planting stock to farmers is a major bottleneck due to lack of micro and macro nutrients, pesticides and diseases. Various nursery methods are individually available for pest, disease and nutrient management however, there is a lack of integrated strategies to manage growth, pests and diseases, therefore, the product Tree Rich Biobooster (TRB) has been developed to produce quality planting stock for farm and plantation forestry. TRB is developed using organic materials which is an environmentally safe method. The developed product can be used as an alternative to potting medium for raising nurseries. Tree Rich Biobooster is decomposed organic tree biomass residue with appropriate amount of FYM. EC is 0.23 and pH is 6.4. TRB was evaluated for its physico-chemical

parameters such as pH, electrical conductivity (EC), bulk density (BD), ash, macronutrients (N, P, K, Ca, Mg) and micronutrients (Zn, Fe, Cu, Mn). was made for.). It can be used for raising seedlings of important forest tree species like Eucalyptus, Casuarina, Simarouba, Teak, Ailanthus, Gmelina and Neolamarkia species, floriculture and horticultural crops. Promoting the efficiency of this biobooster will increase the productivity of short rotation native tree species.

For further improvement of TRB, locally available waste materials such as flowers and vegetable waste were collected, which were composted after evaluation for nutritional parameters added to TRB. Addition of flower and vegetable manure enriched TRB nutrients and increased germination by 40-45% in tropical tree species. BioBooster is light in weight, so transportation is very easy. Most importantly, the water holding capacity is 5 times higher than conventional potting mix and hence, watering is reduced with very little maintenance of seedlings for more than six months. Since TRB is not expensive, growers need to spend very little money to raise quality planting stock without using conventional potting media/mixes.

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Declaration of conflicting interests

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