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# Evaluation of Inexpensive Bedding Materials for Culm Cutting of *Bambusa balcooa* Roxb. and Its Field Performance

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## Abstract

**Background:** *Bambusa balcooa* Roxb. is a species with multipurpose utility and economic value. Natural forests are being depleted due to human activities so it is necessary to grow important bamboo species in plantations. Effective propagation methods are required to generate large quantities of material for planting and culm cutting has been found to be very promising modified vegetative method. However, suitable low-cost bedding materials are required to ensure the process is efficient and cost effective.

**Methods:** Five different bedding materials (coarse sand, 50: 50 mixture of coarse sand and soil, soil, vermicompost, vermiculite) were assessed for macro-propagation of *B. balcooa* Roxb. using a two-nodal culm cutting method during the summer seasons of 2013 and 2014.

**Results:** Coarse sand was shown to be the most economic and easily accessible bedding material for macro-propagation of bamboo followed by the mixture of coarse sand: soil. The saplings were withstood in the natural conditions.

**Conclusions:** Coarse sand could be used as bedding material for the successful regeneration of bamboo through macro propagation using Culm with two nodes.

**Keywords:** *Bambusa balcooa* Roxb.; Macropropagation; Bedding material

## Introduction

*Bambusa balcooa* Roxb. is indigenous to India [1], and is one of the most important bamboo species recognized by the Food and Agriculture Organisation (FAO) [2].This species is widely used for scaffolding and construction purposes [1,3] due to its strong and durable stems [4], while the edible shoots of this species are pickled [5]. In India, 99% of the total bamboo resource currently comes from natural forests [6]. The Planning Commission of India estimated the economic value of country's domestic bamboo to be Rs. 26,000 crores (equivalent to 43.3 billion US$) in 2015 [7,8]. However, the depletion of natural forests due to uncontrolled deforestation and other human activities such as industrialisation is increasing daily [6,8]. Given its multipurpose utility and economic value, there is an urgent need to increase the availability of important bamboo species like *B. balcooa* Roxb. through plantation forestry in areas where it grows naturally.

Sexual reproduction of *B. balcooa* Roxb. is limited [9]. So, vegetative propagation is widely used conventional, improved, or *in vitro* methods [10]. Conventional (traditional) propagation involves taking rhizome or offset cuttings while the improved method involves culm cutting (spilt culm cutting and branch cutting), layering, and macro-proliferation [11]. *In vitro* techniques are effective but are very expensive and require skilled personnel [10] so are not accessible to rural people. The basic problems with vegetative propagation are low multiplication and rooting rates and low survival of saplings [3,12]. Conventional propagation is popular in rural areas but has several problems like low availability of parent plants, low survival rate and transportation problems due to the large size (4–30 kg) of the propagules [13]. Modified vegetative methods like culm cutting/branch cutting have been reported to be easier, simpler and more effective than conventional methods for large-scale multiplication of bamboo [14,15]. In culm-cutting propagation, horizontal planting of two-nodal cuttings of *B. vulgaris* Schrad. ex J. C. Wendl. was found to be more effective than three-nodal culm cuttings during summer [16].

A key component of successful propagation is the substrate used. Previous studies on macro-propagation of bamboo have used a range of substrates including: fine sand for eight bamboo species (including *Bambusa balcooa* Roxb.) [10]; sand for *Bambusa balcooa* Roxb. [17]; loamy material for *Bambusa nutans* Wall. ex Munro, *Dendrocalamus hamiltonii* Nees & Arn. ex Munroand *D. hookeri* Munro for a culm-cutting method [18]; and a mixture of coarse sand and gravel for branch cuttings of *Bambusa nutans* Wall. ex Munro [13]. No reports are available on the effect of other low-cost growth substrates such as vermicompost, vermiculite or soil on macro-propagation of bamboo although these have been used for several other types of plant. For example, Vermicompost was used in rooting of yacon (Smallanthus sonchifolius) [19] and vermiculite for guava (*Psidium guajava* L.) [20].

The aim of the present study was to evaluate five different low-cost substrates (coarse sand, a 1:1 mixture of coarse sand and soil, soil, vermicompost and vermiculite) for propagating two-nodal culm cuttings of *B. balcooa* Roxb. Two-year-old culms were selected for the experiment because of previously reported high survival rates of this

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species by the culm-cutting method [21]. Experiments were conducted during summer (March-May) of two consecutive years. In addition, a field trial was conducted in a rural area to determine the survival of material propagated using these substrates.

## Materials and Methods

Five nursery beds of uniform size (15.75 ft (4.8 m) x 4.75 ft (1.4 m)) were prepared separately using one of five different low-cost bedding materials i.e.: coarse sand of size 2-4 mm (100%); coarse sand: soil (50:50); Clayey loam soil (100%); vermicompost (100%) having Nitrogen-6.3%, Phosphorus-1.03%, Potassium-0.58%, pH-5.9 and vermiculite of Keltech Energies Ltd make (100%).

Two-year-old culms of *B. balcooa* Roxb. were collected from Bamunghata, South 24 Pgs., West Bengal, and transported to the green house (15 km away) by vehicle. Culms were cut from parent plants at a height of 1.5 ft (0.46 m) above the ground to avoid any damage to the parent plant. Culms were approximately 10-12 m long. Weather data of the collection site were collected from the meteorological department of Kolkata, Alipur branch, West Bengal (Supplementary file). Before the experiment, all on the culms were trimmed with a sharp knife without harming the matured culms and buds. Trimmed culms were treated with an aqueous solution (1% w/v) of the fungicide Bavistin (Biostadt, Mumbai, India) for 1 hour. The two cut ends were then sealed with wet soil mixed with the insecticide Furadon 3G (Carbofuran 3% G; FMC Corporation, Bangalore, India). The nodal ring of each trimmed culm was coated with a commercial herbal rooting-hormone product Arodix, Grade IV for Bamboo (PharmaFlora Kolkata, West Bengal, India)

The chemically treated cutting materials were buried at a depth of 0.5 inches from the surface in the different bedding materials horizontally and were planted in 3 rows of 20 plants/row. Water applied through sprinkler method at one week interval during the experiment and no fertilizers was used. The experiment was conducted in 2013 and repeated in 2014 using fresh bedding materials. Key aspects of the experiment are shown in Figure 1.


**Figure 1:** a. Two-nodal culm sections buried into inexpensive bedding material during experiment.
b. Shooting of cutting materials in all five inexpensive bedding materials at 60 days of experiment.
c. Shoots and roots were regenerated from node of cutting materials.
d. Shoots and roots of a two-nodal culm section grown in coarse sand (100%) after 90 days.
e. Shoots and roots of a two-nodal culm section grown in vermiculite (100%) after 90 days.
f. Potted plantlets.

| T | 2013 | | | | | 2014 | | | | | 2013 & 2014 Pooled | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | **T1** | **T2** | **T3** | **T4** | **T5** | **T1** | **T2** | **T3** | **T4** | **T5** | **T1** | **T2** | **T3** | **T4** | **T5** |
| 15 | 36 | 16 | 12 | 33 | 20 | 21 | 16 | 18 | 25 | 10 | 28 | 16 | 15 | 29 | 15 |
| 30 | 54 | 42 | 29 | 54 | 42 | 51 | 35 | 27 | 44 | 27 | 53 | 38 | 28 | 49 | 35 |
| 45 | 47 | 50 | 42 | 55 | 52 | 70 | 42 | 50 | 60 | 42 | 59 | 46 | 46 | 57 | 47 |
| 60 | 46 | 42 | 37 | 43 | 42 | 57 | 37 | 43 | 47 | 25 | 51 | 39 | 35 | 45 | 33 |
| 75 | 37 | 35 | 34 | 37 | 33 | 48 | 30 | 38 | 33 | 28 | 43 | 32 | 30 | 33 | 23 |
| 90 | 32 | 24 | 32 | 32 | 24 | 31 | 25 | 30 | 24 | 22 | 30 | 26 | 28 | 15 | 20 |

T= Treatments; T1 = coarse sand (100%); T2 = coarse sand: soil (50:50); T3 = Soil (100%); T4 = vermicompost (100%); T5 = vermiculite (100%)

**Table 1:** Shooting percentage under different bedding materials at different time intervals over two planting seasons (out of 120 nodes; 60 per season).

Data were collected at two-week intervals from 14 days to 90 days to record the level of shooting per treatment (Table 1). After three-months, the number shoots present were recorded for each culm as were the proportion of culms with roots, the number of roots per culm and the root length per culm. Culms with shoots were taken out of each bed and those plants with both shoots and roots were transferred to plastic pot sand kept separately in the greenhouse for one month.

Ten regenerated plantlets of each treatment were transferred to a field trial, which was carried out at Village: Kastogoara, Rupnarayan Beat, Garbeta block, Paschim Medinapur (West Bengal). Plantlets were arranged in four replicates, each having ten macro-propagated plants.

| Two nodal cutting | | | | |
|---|---|---|---|---|
| Plant character | Duration of experiment | | | |
| | 3 month | 6 month | 9 month | 12 month |
| Average Plant height (in cm) | 139.7 | 198.12 | 302.26 | 425.45 |
| Average Internodal length (in cm) | 3.56 | 3.61 | 4.35 | 4.89 |
| Average intermodal diameter(5th node) | 4.21 | 5.67 | 6.74 | 9.4 |
| Survival percentage | 100 | 100 | 100 | 100 |

**Table 2:** Pooled growth and survival data from the field trial of *B. balcooa* Roxb. in Garbeta block up to 12 months.

Data regarding survival rate, Physiological parameters i.e; intermodal distance, plant height and internodal diameter (with respect to 5th node) and survival rate were taken at three-month intervals (Table 2) for 12 months. Key aspects of the experiment are shown in Figure 2.

Statistical analyses of recorded data were performed using SPSS v16.0 for Windows (SPSS Inc., USA) with 5% probability level of statistical significance.

## Findings

Generally, shooting percentage during the first 90 days of the experiment reached a maximum within the first 45 days (Table 1). Some shoots became dry after this time, which may be due to high temperature and water scarcity during the summer season. The highest percentage of shoots at 90 days was found in coarse sand (100%), soil (100%) and vermicompost (100%) in 2013 (Figure 3). In all cases, the level was significantly lower in 2014, particularly for vermicompost (100%), which may be due to environment temperature particularly. Coarse sand (100%) was found to be the best of the bedding materials based on the proportion of culms with roots, the number of roots per culm and the root length per culm as well as the number of shoots. Plants grown in vermicompost (100%) or vermiculite (100%) had


**Figure 2:** Field trial (2014) of *Bambusabalcooa* Roxb. in Garbeta block. Plant height at: a) 3 months; b) 6 months; c) 9 months; and d) 12 months.

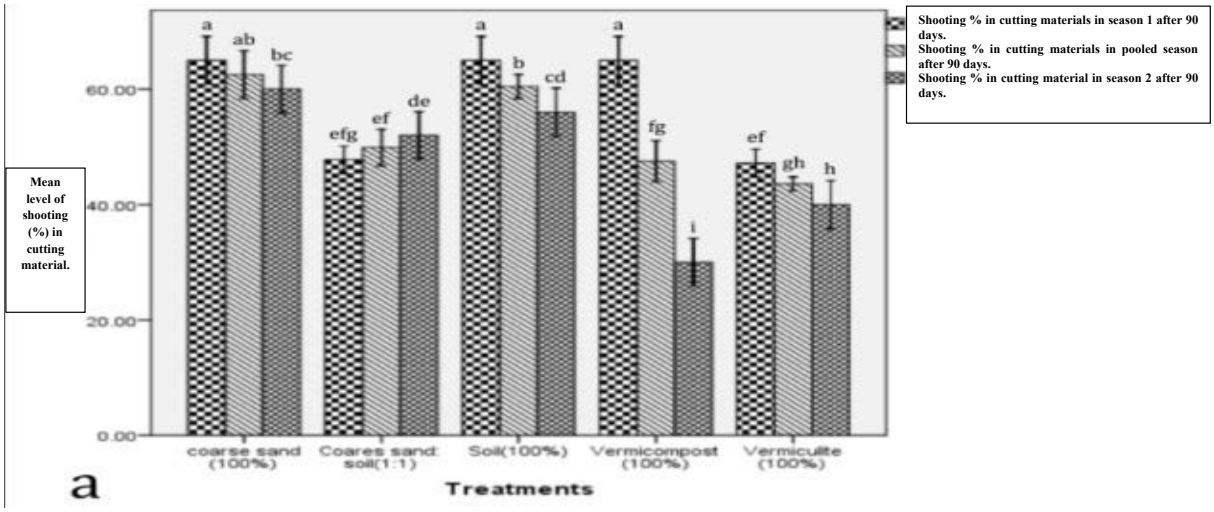


**Figure 3a:** Shooting percentage of culm cutting material of *B.balcooa* Roxb. under different inexpensive bedding materials after 90 days in two consecutive summer season and pooled season.

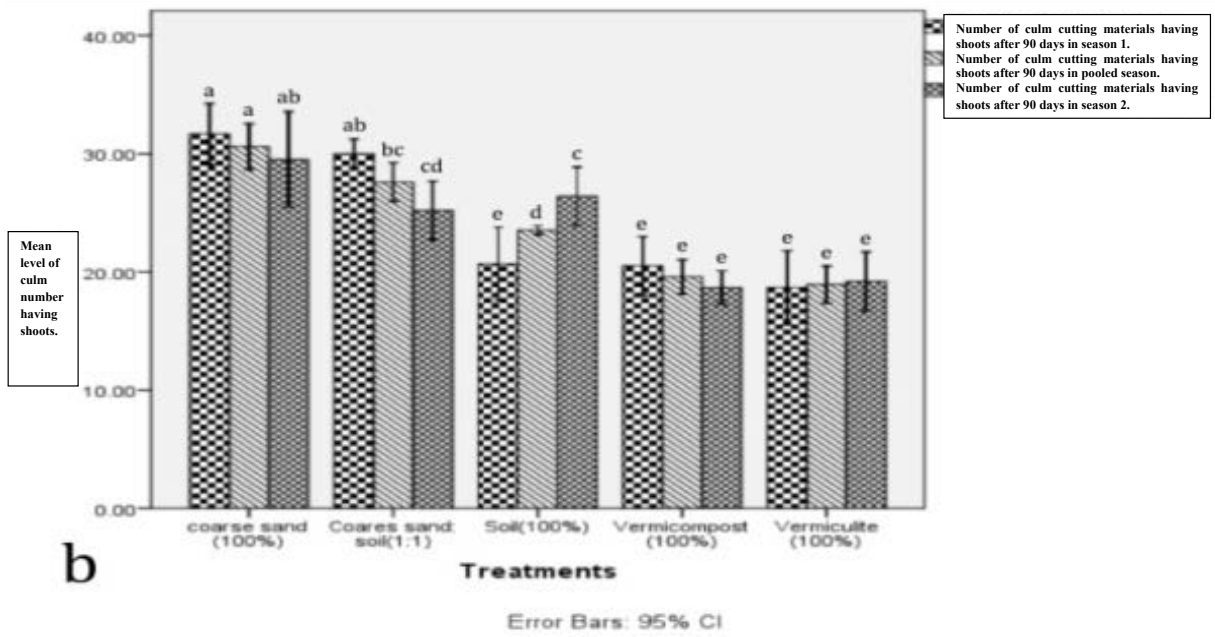


**Figure 3b:** Number of culm cutting material of *B.balcooa* Roxb. having shoots under different inexpensive bedding materials after 90 days during two consecutive summer season and Pooled season.

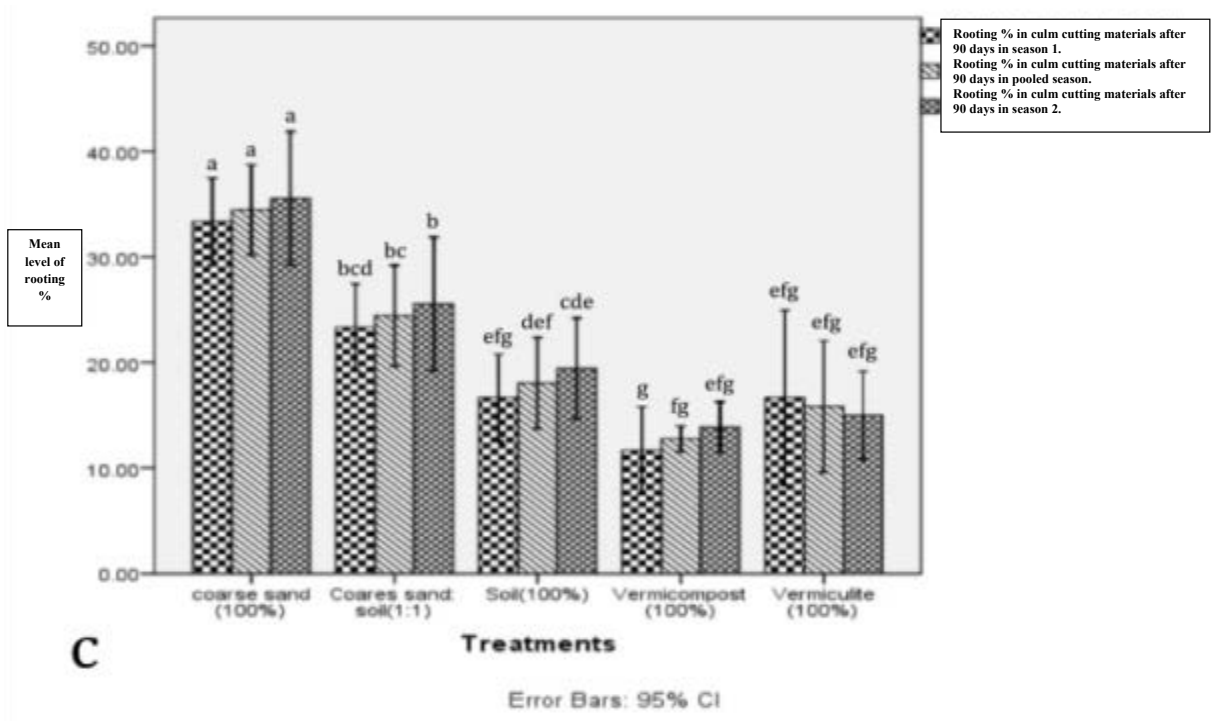


**Figure 3c:** Rooting percentage of culm cutting materials of *B. balcooa* Roxb. under different inexpensive bedding material after 90 days during two consecutive summer season and pooled season.

good root lengths but a low rooting percentage, and many shoot found dead later. In the current study, the rooting percentage in coarse sand (100%) was lower than rooting percentage of *Bambusa balcooa* Roxb. through culm cutting in fine sand [10] for the same season but had higher shooting and rooting percentages compared with the findings of Joshi et al. [17] who used misting conditions for the same species. However, Stapleton [18] reported poor rooting of culm cuttings of *Bambusa nutans* Wall. ex Munroin a loamy bed. Effective rooting media for vegetative propagation should minimise water loss from the buried part of plant and remain moist and well aerated as these are essential for root growth and development [11]. Sand (100%) may suitable for propagation of bamboo since it has all the criteria mentioned above

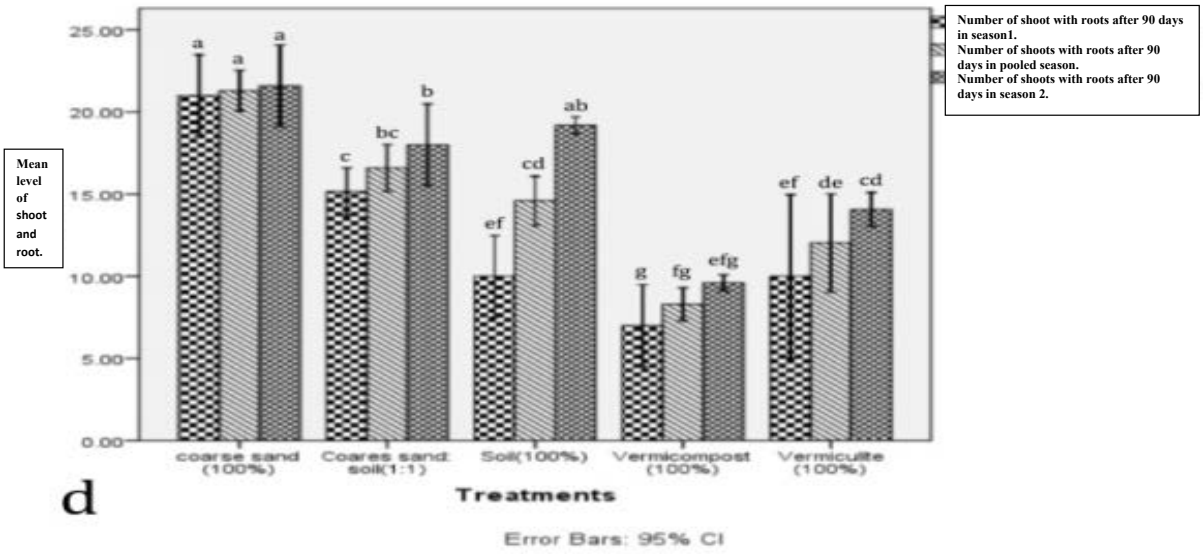


**Figure 3d:** Number of shoot with root from culm cutting material of *B.balcooa* Roxb. under different inexpensive bedding material after 90 days during two consecutive summer season and pooled season.

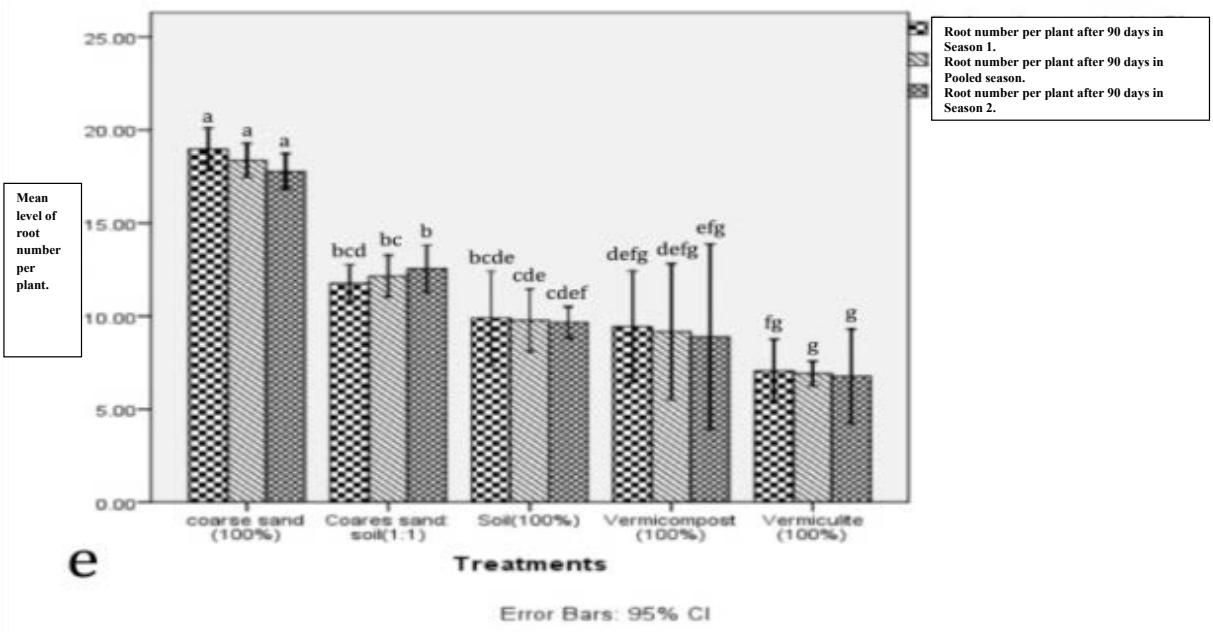


**Figure 3e:** Number of root per plant regenerated from the culm cutting material of *Bambusa balcooa* Roxb. under different inexpensive bedding material after 90 days during two consecutive summer season and pooled season.

for suitable rooting medium. Advantages of sand as rooting bedding materials are it is cheap, locally accessible, provides good drainage system, and maintains a uniform temperature in the bed [11]. The percentages of shooting and rooting may be improved by altering the sand type (fine sand in stead of coarse sand) or using one nodal cutting (since it would be easier to handle [9] or by increasing the rooting hormone concentration.

All macro-propagated plantlets that were transferred to the field trial survived up to 12 months after transplanting (Table 2). No variation among the treatment with respect to survival rate was found.

## Conclusion

Coarse sand (100%) was superior to other four other low-cost materials tested for macropropagation of culm cuttings of *Bambusa balcooa* Roxb. Vermicompost and verculite are not suitable for macropropropagation of bamboo due to their low rooting capacity.

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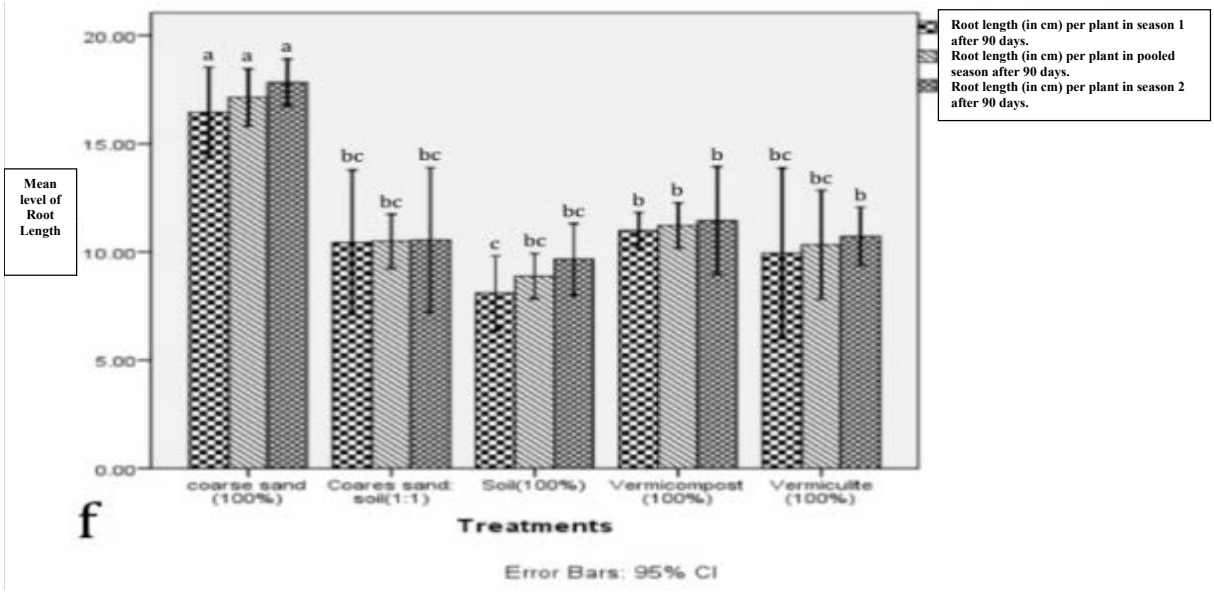


**Figure 3f:** Root length (cm) per plants of *Bambusa balcooa* Roxb. regenerated from culm cutting material under different inexpensive bedding material after 90 days during two consecutive summer season and pooled season.

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