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Regeneration Technique of Bamboo Species through Nodal Segments: A Review

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Abstract
Micropropagation is an alternative technique to propagate at large scale plants to meet global plant demand. Various researchers have worked on the micropropagation technique to regenerate bamboo species by using nodal segments from years. Contamination, browning, necrosis, and acclimatization with physiological stress are the extreme problems of the micropropagation technique. But, many numbers of papers have been published on micropropagation of the bamboo species through nodal segments as explants. The proliferation of the bamboo shoots is dependent on the season of collection, size of explants, the position of explants, diversity of plants, concentration and combination of plant growth regulators, most adequate culture medium, environmental condition of the equipment, handling, and individual species. Bamboo is a monocarpic fast-growing, tall perennial grass and having the high potential to generate economic and social benefits. It helps to maintain land patterns and control soil erosion. The long life cycle of the bamboo produces a huge amount of seeds but unfortunately, mostly, they are non-viable. So, bamboos are propagated from vegetative by cutting and air layering. However, these methods are only for a small scale and they also tend to destroy large mother plant stocks and difficult to be transported. So, the *in vitro* propagation technique is useful to obtain large progenies from desired genotypes. Mostly, BAP and TDZ growth hormones are widely used for shoot multiplication and IBA, NAA and IAA are used for root initiation as per developed protocols in tissue culture for large scale production. This review intends to explore an overview of the recent literature reports to summarize the importance of micropropagation by using nodal segments of bamboo species and factors influencing it.

Keywords: Micropropagation, Nodal segments, Bamboo species, Plant Growth Regulators, Shooting and Rooting

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Introduction
Bamboo is an attractive plant species for various purposes due to its versatile utilization with high economic potentiality and its accelerated growing capacity at short period [1, 2]. It is perennial strong woody giant grass [1-5] having a unique complex branching system of rhizomes with root. It belongs to subfamily Bambusoideae of the Poaceae family and subsequently divided into three tribes [3, 4, 5, 6]. It can grow from approximately 75 to 400mm per day [7]. It is distributed up to 4000 m. a. s.l. in temperate to the zone of all continents except Europe [8]. It prefers to grow at a minimum of 100 cm annual rainfall with high atmospheric humidity in steep hillsides, road embankments, gullies, or on the banks of ponds and streams [9]. It occupies 3% of the forest in the tropical, subtropical, and temperate zone of the world but while, in Asia; it covers 10 % of the forest. There are 120 genera and 1641 species found in the world [10, 11 and 12]. Tropical Asia has rich bamboo diversity with up to 60 genera and 1000 species [13]. However, Nepal has only 12 genera and 65 species of bamboos distributed in the tropical, subtropical, and temperate zone [14].

Since the ancient period, bamboo species are widely used as a renewable source due to its versatile nature [15, 16]. According to Hsiung (1988), more than 4000 traditional uses and 1500 commercial applications have been known to bamboo. It's multipurpose potentiality from cradles to coffin and as "Green Gold" [17]. Similarly, it is used for making paper, pulp, food, scaffolding, textiles, plywood, boards, raw materials for construction, fencing, clothes, reinforcing fibers, etc, and bio-energy applications [10]. Also, it is used as an alternative source of energy and helped to prevent soil erosion due to the closely woven mat of intertwining roots and rhizomes [17, 18] with its high agro-climatic suitability.

It is perennial plants with monocarpic nature having vegetative and reproductive cycle range from 3 to 120 years [19], sporadic flowering with the recalcitrance of seeds which made difficult for identification and floral characterization of bamboo. Mostly, the classification and identification of bamboo is done based on the vegetative pattern but it is not reliable due to influence of ecological factors an easily practicable because bamboo can produce a limited number of seeds after a long period of its life span which has short viability period only 3 to 6 months [17, 18, 19] and suffering from insects and rodents. Hence, the bamboo is regenerated through the vegetative method by planting of rhizome off-set, branch & culm cuttings, nodal macro-cutting and layering [20, 21] but for this process, it needs a large mass of bamboo plant stocks. This leads to the destruction of entire clumps and the gradual depletion of bamboo resources. Again, it is not easily available sufficiently due to seasonal dependency and low rooting capacity so it is highly expensive [17]. Similarly, it is difficult to transport and handle due to heavyweight and long length [22, 23]. Also, there is more chance of liable desiccation before rooting [24]. Moreover, yield production of bamboo is hardly possible [22-27] through conventional and non-conventional methods. Therefore, it is necessary to apply other techniques of plant tissue culture because it is highly demanded the industry to agriculture.

In Vitro Propagation of Bamboo

Plant tissue culture is the only advanced technique that can be applied to solve the challenges of speedy and mass propagation of the bamboo species [27]. For the conservation of bamboo and to fulfill the growing demand of the markets, micropropagation is the alternative method that provides rapid mass multiplication of bamboo along with disease-free plants as well as the same clone [25-32]. Micropropagation is not only ensuring the supply of quality planting material regularly but it also helps in conserving of germplasm of bamboo [25].

Different types of explants viz. seed, seedlings, inflorescences, root, culm, mature clumps, nodal segment, meristem domes or leaves, etc [33, 34, 35] are used for bamboo micropropagation. In bamboo, both juvenile and mature plants can be considered as explants [36]. The nodal segments containing is considered as more effective explants for *in vitro* culture because of resumed food materials. Due to the presence of highly active meristematic tissue in nodal segments, it develops into new plantlets [37]. The response of explants depends on the physical condition of plants, the health of mother plants, collection of the season from field and size of explants, and its position in mother plants [38]. Using nodal explants for organogenesis reduces the chance of somaclonal variation [27].

There is so much research conducted on micropropagation of bamboo through nodal explants [27-47] However, the developed protocols are either insufficient or not applicable because the protocols are only limited to the research which is not applicable for industrial mass production. It is intended to explore the suitable protocols on the micropropagation technique for mass bamboo propagation. This review intense to give an overview of the recent literature reports to summarizes the importance of micropropagation by using nodal segments of bamboo species and factors that influence it.

Collection of explants

Nodal explants were collected from January to February, March to April, May to June, July to August), September to October, and November to December [32, 41, 48]. The establishment of explants in culture was directly related to the collection of explants seasons and plants species which influenced in pure culture. It was dependent on external factors i.e. contamination and concentration of the hormones in media [49]. Explants collected during February-March and September-October showed maximum bud break [48]. It was reported that the rainy season was better for bud break in *Dendrocalamus strictus* [49] *Bambusa tulda* [40] *Gigantochloa atroviolacea* [50] with the high rate of contamination [40, 51, 52]. The explants collected from November to January (winter months) produced only 35-45% bud break response during the culture of *Bambusa vulagaris* by [53]. Spring and summer season (February to June) was a comparatively better period for the collection of explants [37]. However, Negi and Saxena [29, 30] have obtained high aseptic cultures along with a 90% bud response from July to October in *Bambusa balcooa*. According to Negi and Saxena (2011) and Mehta et al. (2011), the best collection of explants was in July for culture initiation in *Bambusa nutans*. But Singh et al. (2012b) reported the collection of nodal explants at pre-monsoon induced maximum

bud break in *Dendrocalamus asper*. Ramanayake et al. (1995) observe that the influence of seasons on bud break was countable in *D. giganteus* and *Berberis vulgaris*. It was observed that seasonal effects on bud initiation and found that February to March is a good period for obtaining auxiliary buds for cultural development [54]. Moreover, Shivabalan et al. (2014) have established a new culture form explants of *B. balcooa* collected in December. In other seasons, the establishment of pure culture is difficult due to the high scale of contamination suffering from the variable pathogen in the summer and rainy season. Better establishment of pure aseptic cultures and bud response of explants depends on the ratio of contamination, handling, physiological state of explants, species, type of explants, and the season of collection [24, 43, 52, 55, 56, 57, 58, 59].

Different aged of the mother stock plants were also used for culture initiation. The new Culm (1 year) and lateral branched (frequently actively branched) of 2 to 5 years old bamboo can be used as explants [25, 43]. But Patel et al. (2015) have established *in vitro* culture from 2 to 30 years old explants and also Sharma et al. (2012) used nodal explants from the current year's growth mature and healthy clumps of *Bambusa nutans*. Similarly, nodal explants of 40 years old *B. nutans*; 30 years old *B. balcooa* [60] and 10 years old *B. tulda* were used for multi proposed [59, 61]. The aged of the explants could not effectually determine in the initiation of the shoot *in vitro*. Furthermore, there may be some result influenced by the age of the plants during the experiment but there was no impact reason behind it. It depended on the composition of media, concentration of hormones, contamination rate, and condition of the culture [31]. Also, various aged of the explants can be established successfully *in vitro* culture through single nodal segments from bamboos.

Position of the Nodal Explants

To date, only limited researchers have mentioned the position of nodal explants in mother plants. Nodal segments from the healthy mature mother plant with disinfected lateral branches and were more effective for the initiation of the culture [62]. Chowdhury et al. (2004) recorded that the 1st and 2nd position from the base of secondary branches of *D. strictus* was the best for regeneration in micropropagation. But, according to Mudoi et al. (2008, 2014), the 5th to 7th position of the *B. balcooa*, *B. nutans* and *B.tulda* explants from mother stock culm was best for maximum regeneration *in vitro* culture rather than below 5th position because the base explants can excaudate phenolic compound which resulted in browning problem on shoots. A similar result was also illustrated in the report of Devi and Sharma (2009) in which the top position of explants showed a low frequency of bud break in comparison to the basal and mid Culm nodes in *Arrundinaria callosa* Munro. Middle node explants of Culm were very effective resulted *in vitro* propagation of the *B. vulgaris*, [63]. Another experiment revealed that the auxiliary branch of explants from healthy mother stock was found to be good for regeneration of the new plants such as in *D. hamiltonii* [1, 64], *D. asper* [65], *D. giganteus* [56]. Similarly, Sharma and Sarma (2013) reported that young lateral buds also showed the bud break in *B. tulda*. Therefore, it is stated that the top and the base portion of the nodal segment in Culm bamboo can hardly regenerate *in vitro* propagation of bamboo.

Surface Sterilization

The size of 2.5 mm explants was more effective than a smaller size (5-7 mm) to initiate the culture within a short period because of high endogenous hormonal effect [37, 41]. For the initiation of the culture, the explants were surface sterilized by treating different kinds of chemicals for a certain time to avoid the contamination. It was reported that explants treated in 70% ethanol for the 30s to 1 min [25, 29, 30, 31, 33 39] followed running tap water after washing in 4-6 drops of detergent (Tween 20/Tween 80) for 30 mins. [29, 30, 33, 68] reduced the rate of contamination. It was reported that 0.1% Mercuric chloride ($HgCl_2$) was found more effective than other surface sterilants (Sodium hypochlorite, Potassium Hypochlorite, Hydrogen Peroxide, etc.) for various species of bamboo micropropagation [29-,31, 33, 35, 36, 38, 39, 65- 71]. So it is suggested that 0.1% Mercuric Chloride was more effective for the disinfection of the explants because the high concentration of the $HgCl_2$ retarded the growth of plants due to the impact of chemical in the internal tissues [72]. Wei et al. (2015) have reported that the treatment of explants on 0.1% $HgCl_2$ at lower duration enhanced the survival rate of explants and frequency of bud break. When treatment time was increased at the same concentration of $HgCl_2$ in *D. strictus,* the bacterial and fungal contamination was decreased [36]. Similarly, for the establishment of a pure culture of bamboo, different researchers have

used antiseptics like savlon, tempol, streptomycin sulphate, gentamicin, cetavelon, etc [29, 40, 42, 60] and fungicide like bavistin, benomyl, mancozeb, carbendazim, tetracycline, etc [37, 41, 42. 49, 53, 56].

Culture Media

According to Chang and Ho (1997), the nutritional composition is greatly varied in culture media which depends on the types of tissues and plant species. So, for the establishment of the culture, the proper media play a major role in the growth and development of the plants. It is difficult to consider a unique media for all types of plants in tissue culture. Not only for getting maximum auxiliary bud breaking, but MS [78] medium has also been widely practiced for more superior responsive bud proliferation and further multiplication of bamboo in comparison to other media such as SH (Schenk and Hildebrandt 1972), B5 (Gamborg et al. 1968) and NN (Nitsch and Nitsch 1969), WP Medium (Lloyd and Crown 1980) [34-122]. But Kabade (2009) observed that the WPM media is suitable for shoot induction from nodal segments of *B. bambos*. Similarly, Shirgurkar et al. (1996), Singh et al. (2001), Ogita et al. (2009), and Negi and Saxena (2011) reported that the half-strength rather than full strength MS medium was better for successful *in vitro* culture in bamboo [123-124].

The physical condition of the media is also a factor that influences to grow plant tissue under *in vitro* culture. Several researchers reported that the proliferation and shoot multiplication of the bamboo was successfully obtained under *in vitro* culture on semi-solid/solid MS media [34, 35, 36, 39, 40-48]. Mostly, 0.8% agar was widely used as a gelling agent to solidified/semi-solidified the media which influenced the plant metabolism [32-39, 76]. Some researchers also used phytagel (0.2%) or Gelrite (0.2-0.35%) to agar which influenced high bud breaking in *B. wamin* [72] and shoot proliferation in *B. oldhamii* [77]. Similarly, it was noted that dwarf and a lower number of shoots per explant in MS solid media due to leaching and browning problems [79]. Similarly, Sharma and Sarma (1998) have also observed leaching of phenolic exudates and poor growth of shoot in MS agar gelled medium. Several reporters mentioned that liquid MS media was also observed more suitable than MS semi-solid/ solid media for proliferation and multiplication of the shoots in bamboo species [34, 43, 78]. The high rate of shoot initiation has observed in the liquid medium compared to agar gelled medium means attributed to easy availability and faster uptake of nutrients in liquid medium [81]. When culture initiated in liquid media generally shoots were grown faster and less required hardening time [82].

Plant Growth Regulators

The chemical substances which influenced either promote (positive) or inhibit (negative) the growth of the plant are plant growth regulators (PGR). The low quantity of PGR can change the morphological structure of plants. Natural and synthetics phytohormones are widely used in tissue culture. Mostly cytokinins and auxin are used for callogenesis and histogenesis of bamboo. Different concentration of the 6–Benzyl aminopurine (BAP), 6–Benzyl adenine (BA), Napthalene Acetic Acid (NAA), Indole 3-Butyric Acid (IBA), Indole Acetic Acid (IAA), Zeatin (ZN), kinetin (KN), Thidiazurn (TDZ) with the supplement of 3% sucrose and 100 mg/L Myo-Inositol was used on the micropropagation of the bamboo. The growth regulators hormones used by researchers in **Table 1**. There were various factors affect the initiation of an aseptic culture of explants. The rate of percentage on bud break was varied with different concentrations of plant growth hormones, condition, physiological status of explants, size, the position of the explants, age of mother plants, the health of mother stock and collection season of explants. Mostly, BAP and BA were widely used for micropropagation of bamboo because it might be cost-effective and autoclave nature [36], and ultimately BAP and BA showed successful results when in cooperated within MS media for bud breaking, proliferation, and multiplication of shoots of several bamboo species. But Arya et al. (2003) could not obtain an axillary bud break in *B. tulda* in the presence of BAP only. Venkatachalam et al. (2015) have reported that 85% bud break was obtained separately or a combination of different concentrations of BAP, NAA, and KN with a supplement of Additivesincooperation with MS solid media. Moreover, similar combined effects of two cytokinins (BAP and KN) in different concentrations have found successfully result in bud breaking and shoot initiation of *B. arundinancea* Retz. Wild [84]. However, In shoot initiation experiment, different researchers have tried auxin (NAA, IAA) along with different combinations of cytokinins (BAP, KN, and TDZ and also suggested that increased levels of BAP and KN retarded in bud initiation [23, 57, 58, 62, 78].

Table 1. Micropropagation from Nodal segments/Explants

Bamboo Species	Plant Growth regulators			Results	Ref
	Bud breaking	Shoot Multiplication	Rooting		
Arundinaria callosa Munro	Liquid MS + BAP(13.3 µM/L)	Liquid MS + BAP (13.3 µM/L) + IBA (1.0 µM/L)	1/2 MS Liquoid + IBA (25 µM) + BAP (0.05 µM/L)	Shoot multiplication and Rooting	70
B. arundinacea	BAP (5.0 mg/L)	BAP (5.0 mg/L)	NAA (3.0 mg/L)	Mass multiplication	79
B. arundinacea Retz. Willd	MS + BAP(3.0 mg/L) +KN (0.5 mg/L)	MS +BAP (3.0 mg/L) + KN (0.5 mg/L)	½ MS+ IBA (2.0 mg/L) + KN (0.5 mg/L)	Mass multiplication	94
B. balcooa	-	BAP (11.25µM/L) +KN (4.5 µM/L)	1/2 MS+ IBA (1.0 µM/L)	*In Vitro* regeneration	67
B. balcooa	BAP (1.0 mg/L)	BAP (1.0-5.0 mg/L)	1/2MS+NAA(1-3mg/L) + IBA(1 -5. mg/L)	Mass multiplication	112
B. balcooa	MS +BAP (4.4 µM/L)+NAA (0.53µM/L)	MS + BAP (4.4 µM/L)+ NAA (0.53µM/L)	MS + NAA (16.11 µM/L)	Mass multiplication and Rooting	49
B. balcooa Roxb	MS+ citirc acid (25mg/L) + ascorbic (50 mg/L) +BAP (3.5 mg/L)	MS+ BAP (3 mg/L)+ NAA (0.5 mg/L)	MS +NAA (4 mg/L)	Mass multiplication and Rooting	51
B. balcooa	MS+TDZ (0.1 mg/L)+ Gelrite (2g/l)	MS + TDZ (0.1 mg/L)	MS + TDZ (0.01 mg/L) + 2,4-D (0.5 mg/L).	Mass multiplication and Rooting	85
B.balcooa	MS + BAP (1 mg/L)	MS+ BAP (1 mg/L)	MS+ BAP (1 mg/L) + NAA (3mg/L)	Mass multiplication and Rooting	61
B.balcooa	MS+ BAP (4 mg/L)	Liquid MS + BAP (4 mg/L)	MS Liquid+ IBA (1mg/L)	Mass multiplication and Rooting	68
B.balcooa	Liquid MS + BAP (1 mg/L)	MS+BAP (1.0-5.0 mg/L)	½ MS+ NAA (3 mg/L)/ IBA (5 mg/L)	Mass multiplication and Rooting	112
B.balcooa	Liqiud MS + BAP (11.25 µM/L) + KN (4.5 µM/L)	Liquid MS + IBA (1 µM/L)	½ MS Liquid) + IBA (1 µM/L)	Mass multiplication and Rooting	98
B.balcooa	MS+ BAP (4.4 µM/L) + KN (2.32 µM/L)+ Gelrite (0.2% w/v)	Liquid MS + BAP (6.6 µm/L)+KN (2.32 µM/L)+ Coconut water (2.5% (v/v)	1/2 MS +IAA (5.71 µM/L)+ IBA (4.9 µM/L)+NAA (5.37 µM/L)	Mass multiplication and Rooting	34, 35
B.balcooa	MS + BAP (3 mg/L)	MS + BAP (5 mg/L)	MS +NAA (4.5 mg/L)	Mass multiplication and Rooting	124
B. bambos	MS + BAP (4.4 µM/L)	MS+ BAP (4.4 µM/L) + KN (1.16 µM/L)	MS+ IBA (9.80 µM/L)	Mass multiplication and Rooting	49
B.bambos	MS + BAP (4.4 µM/L)+KN (1.16µM/L)	MS + BAP (4.4 µM/L)+KN (1.16 µM/L)	MS + IBA (9.80µM/L)	Mass multiplication and Rooting	49
B.bambos	…	BAP (5.0 mg/L)	NAA (3.0 mg/L)	Micropropagat-ion	48
B. edulis	BAP (1mg/L)/ BAP(1mg/L)+ NAA(1mg/L)	TDZ (0.01 mg/L)	TDZ (0.01 mg/L)	Micropropag-ation and In- vitro flowering	85
*B.glaucescens*Willd	MS + BA (5 µM/L)	Liquid MS+ BA(5 µM/L) + KN 15 µM/L)	MS+ IBA (25 µM/L)	Mass multiplication and Rooting	99
B. nutans Wall ex. Munro	MS+ BAP (1.0 mg/L)	MS +BAP (0.5 mg/L) + NAA (0.1 mg/L).	MS+ NAA (2.0 mg/L)	Mass multiplication and Rooting	29
B. nutans Wall ex. Munro	Liquid MS+ BAP (1 mg/L)	MS+ BAP (1.0-5.0 mg/L)	½ MS +NAA(3.0 mg/L)/ IBA (5.0 mg/L)	Mass multiplication and Rooting	112
B. nutans Wall ex. Munro	MS+ BA (2.22 µM/L)	Liquid MS+ BA (2.22 µM/L)	MS+ IBA (49.0 µM/L)	Mass multiplication and Rooting	97
B.nutans	MS + BAP (4.44 µM/L)+ 2,4-D (4.2 µM/L) + 3% Sucrose	MS + TDZ (6.49 µM/L)+ NAA (0.74 µM/L)	Ms +NAA (16.11 µM/L) +2% sucrose	Mass multiplication and Rooting	58
B. nutans Wall ex. Munro	MS+ BA (4.4 µM/L + KN (2.32)	Liquid MS + BA (13.2 µM/L) + KN (2.32 µM/L) + IBA (0.98 µM/L)	½ MS+IBA (9.8 µM/L) + IAA (2.85 µM/L)+ AA (2.68 µM/L)	Mass multiplication and Rooting	34, 35
B. nutans Wall ex. Munro	MS + BAP (5.0 µM/L)	MS + BAP (5.0 µM/L)	MS + IBA (10.0 µM/L)	Shoot multiplication and Rooting	119

B. oldhamii Munro	MS+ TDZ (0.45 µM/L)+ Gelrite (2.2 g/L)	Liquid MS + TDZ (2.27 µM/L)	MS basal + NAA (10.74-26.85 µM/L)	Shoot multiplication and Rooting	85
B. pallida	Liquid MS+ ascorbic acid (50 mg/L) + citric acid (25 mg/L) + cysteine (25 mg/L)+ NAA 1.34 µM/L+ TDZ (1.125 µM/L)	Liquid MS+ NAA (1.34 µM/L)+ BAP (4.44 µM/L)	½ MS+ 2% sucrose +1% glucose + 0.6% agar after treatment of IBA (0.5 µM/L) for 30 min	Mass multiplication and Rooting	111
B. pallida	MS+ BA (1 mg/L) + Gelrite (2.5%)	MS+ BA (3 mg/L)	MS+ NAA (2.0 mg/L)	Mass multiplication and Rooting	88
B. salarkhanii	Liquid MS+ BAP (1 mg/L)	MS+ BAP (1.0-5.0 mg/L)	½ MS+ NAA (3 mg/L)/IBA(5 mg/L)	Mass multiplication and Rooting	112
B. tulda	MS+ BA (1.0 mg/L)	Semi-solid MS+ BA (1.0 mg/L)	MS+ NAA(5 mg/L)	Mass multiplication and Rooting	88
B. tulda	semi-solid MS+ BA (10 µM/L) + IAA (0.1 µM/L)	MS (L) + glutamine (100 µM/L) + IAA (0.1 µM/L) + BAP (12 µM/L)	MS liquid medium + 40 µM/L Coumarin	Mass multiplication and Rooting	47
B. tulda	MS+ BAP (3mg/L)	Liquid MS+ KN (2mg/L) + BAP (3mg/L)	½ MS+ IBA (3mg/L)+ coumarin 10 mg/L + 3% sucrose	Mass multiplication and Rooting	46
B. tulda	MS (Liquid) + BAP (8.8 µM/L)+ KN(4.46 µM/L) + 2% Sucrose	MS (Liquid) + BAP(8.8µM/L)+KN (4.46 µM/L) + 2% Sucrose	MS (Liquid) + IBA (18.8 µM/L) + 2% Sucrose	Mass multiplication and Rooting	122
B. tulda	Liquid MS + BAP (2.5 mg/L) + KN (1mg/L) + 8% coconut water	Liquid MS+ BAP (2.0 mg /l) + KN (1.0 mg/L)+ 8% coconut water	½ MS + IBA (0.2 mg/L)	Mass multiplication and Rooting	98
B. ventricosa	BAP (4.44 µM/L)	BAP (4.44µM/L)	NAA (5.4 µM/L) + BAP (0.44 µM/L)	*In Vitro* regeneration	53
B. ventricosa	MS+ BA (22.2 µM/L)	MS+ BA (22.2 µM/L) + TDZ (0.23 µM/L)+ NAA (0.27 µM/L)	MS + NAA(2.7 µM/l) +IBA(4.9 µM/L)+ BA (4.4 µM/l)	Mass multiplication and Rooting	78
B.vulgaris	Modified MS+ BAP(2 mg/L)	Modified MS+ BAP (2 mg/L)	Modified MS+ IBA (20 mg/L)	Mass multiplication and Rooting	113
B. vulgaris	Liquid MS+ BAP (1 mg/L)	MS+ BAP (1.0-5.0 mg/L)	½ MS +NAA (3.0 mg/L)/IBA (5.0 mg/L)	Mass multiplication and Rooting	112
B. vulgaris	Liquid MS+ BAP (1 mg/L)	MS+ BAP (1.0-5.0 mg/L)	½ MS+ NAA (3 mg/L) / IBA(5 mg/L)	Mass multiplication and Rooting	112
B. vulgaris	MS+ BAP (2.0 mg/ l)	MS +BAP (4.0 mg/L)	½ MS+ IBA (3.0 mg/L)	Mass multiplication and Rooting	64
B. wamin	MS (L) + BAP (5.0 mg/L)	Semisolid MS+ BAP (2.0 mg/L) +KN (0.8 mg/ l)	½ MS+ IBA (7.5 mg/L)	8	80
D. asper	BAP (0-2.0 mg/L + CW (0-20.0 mg/L)	BAP (5.0 Mg/L)	NAA (0.5 mg/L)	*In Vitro* culture	2,96
D. asper	MS+ BAP (5 mg/L)	MS (L) BAP (5 mg/L) +Ads (40 mg/L)	MS (liquid) + IBA (1 mg/L)	Shoot multiplication and Rooting	103
D.asper	MS+ BA (0.1-15 mg/L)	MS (L) + IBA (3 mg/L)	MS + IBA (10 mg/L)	Shoot multiplication and Rooting	25
D. asper	BAP (3.0 mg/L)	BAP (1.0-4.0 mg/L	NAA (2.0 mg/L) or IBA (10.0 mg/L)	Shoot multiplication and Rooting	48
D.asper	MS + BAP (15 µM/L)	MS + BAP (10 µM/L) + Ads (75 µM/L)+ Table Sugar 3%	½ MS +IBA (5 µM/L) + NAA (5 µM/l)	Shoot multiplication and Rooting	21
D. asper	MS+BAP (8.86 µM/L)+ Ads (13.5 µM/L)	MS+BAP (8.86 µM/L) + Ads (13.5 µM/L)	MS+ IBA (14.76 µM/L)+ NAA (3.67 µM/L)	Shoot multiplication and Rooting	59
D.asper {Schult. & Schult.f.} Backer ex k. Heyne)	MS+ BAP (15 µM/L)	MS + BAP (10 µM/L)+ Ads (75 µM/L)	½ MS + IBA (5 µM/l) + NAA (5 µM/L)	Shoot multiplication and Rooting	66

D.asper	MS+ BA (3 mg/L)	Liquid MS + BA (3 mg/L) + Ads (50 mg/L)	MS (Liquid) + IBA (1.0 mg/L)	Shoot multiplication and Rooting	2
*D.Brandisii*Kurz.	MS (L) + Ascorbic acid (25mg/L) +Citric acid (12.5mg/L)+Cysteine (12.5mg/L) + Glutamic acid (50 mg/L) + TDZ (0.25 mg/L)+ NAA (0.25 mg/L)	MS (Liquid) + NAA (0.25 mg/L) + BAP (2.5 mg/L)	½ MS (L)+ NAA (1mg/L)	Shoot multiplication and Rooting	86
D. giganteus	BAP (2.0 -5.0 mg/L)	KN (10.0 µM/L) + BAP (0.5 µM/L)	…	Mass multiplication	73
D.giganteus	BAP (30.0 µM/L)	BAP (20.0 µM/L)	IBA (25 µM/L) + BAP (0.05 µM/L)	Rapid multiplication	48
D.giganteus	..		IBA+TDZ+ Coumarin	Root induction	105
D. giganteus Munro	Semi-solid MS+ BAP (2 mg/L) + KN (0.1 mg/L)+ Benlate (1g/L)	MS (Liquid) + BAP(6 mg/L)+ KN (1 mg/L) + 8% (v/v) coconut water	½ MS+ IBA (3 mg/L) + 10 mg/L Coumarin	Shoot multiplication and Rooting	106
*D.hamiltonii*Nees et Arn. Ex Munro	MS+ 2% sugar followed by MS+ BAP (8 µM/L)+ NAA (1 µM/L)	MS+ BAP (8 µM/L)+ NAA (1 µM/L)	MS+IBA (100 µM/L) followed by growth regulator free media	Shoot multiplication and Rooting	102
D.hamiltonii ARN. Ex MUNRO	MS+ TDZ (3.0 µM/L)	MS+ TDZ (1.5 µM/L) + ascorbic acid (56.0 µM/L)	½ MS+ IBA (25.0 µM) + Choline Chloride (36.0 µM/L)	Shoot multiplication and Rooting	62
D. Longispathus KURZ.	MS+ BAP (12 µM/L)+ KN (3 µM/L)	MS (L) + BAP (15 µM/L)+ IBA (1 µM/L) + Coconut Water (10%)	½ MS+ IBA (1µM/L)+ IAA (1µM/L) +Coumarin(68 µM/L).	Shoot multiplication and Rooting	28
D. membranaceus	MS +BAP (1-5mg/L NAA (0.5 g/L)	BAP (1-5mg/L) + NAA (0.5 mg/L)	NAA (3.0 mg/L) / IBA (10.0 mg/L)	Mass multiplication	73, 79
D. membranaceus	MS + BAP (4.4 µM/L) + KN (1.16 µM/L)	MS + BAP (4.4 µM)+ KN (1.16 µM/L)	1/2 MS + NAA (5.37 µM/L) + BAP(4.4 µM/L)	Mass multiplication and Rooting	49
D. strictus	MS + BAP (2.0-5.0 mg/L)	BAP (2.0-5.0 mg/L)		Mass multiplication	73
D. strictus Nees	White medium	Liquid MS+ BA (0.5 mg/L)+ KN (0.5 mg/L)+ Coconut Water (200 ml/L)	Solid MS+ IBA (0.25 mg/L)	Shoot multiplication and Rooting	1
D.strictus Nees	MS (L)+ BA (0.5 mg/L)+ Ads (15 mg/L)	MS (L)+ IBA (0.5 mg/L)+ Ads (15 mg/L)	1/2MS Liquid + IBA (0.25 mg/L)	Shoot multiplication and Rooting	45
D.strictus Nees	MS + BAP (2 mg/L)	MS + BAP (4 mg/L) + Ads (15 mg/L)	MS+IBA (5mg/L)	Shoot multiplication and Rooting	75
D.strictus Nees	MS+ IAA (0.5 mg/L)+ Ads (15 mg/L)		½ MS+ IBA (1 mg/L)+NAA(1mg/L)+ 2,4-D (0.5mg/L)+ Phloroglucinol (1mg/L)	Shoot multiplication and Rooting	56
D.strictus Nees	MS+ BAP (4 mg/)+ TDZ (0.25 mg/L)	MS+ BAP (4mg/ L)+ TDZ (0.25 mg/ L)	Liquid MS+ BAP (2.5 mg/ L)+ IAA (5 mg/ L)	Shoot multiplication and Rooting	31
D.strictus Nees	MS+ BAP (4 mg/L)	MS + BAP (4 mg/L)	MS+ NAA (3 mg/L)	Shoot multiplication and Rooting	44
D.strictus (Roxb.) Nees	MS+ 2,4-D (5 mg/L)	----------	MS + 2,4-D (0.5 mg/L)	Callus initiation Shoot multiplication and Rooting	31
Melocanna baccifera	MS+ BAP (3 mg/L)	Liquid MS+ KN (2mg/L) + BAP (3mg/L)	½ MS+ IBA (3 mg/L)+ Coumarin (10 mg/L)+ 3% sucrose,	Shoot multiplication and Rooting	46
Thamnocalamusspathiflorus (Trin.) Munro	½ strength MS	MS medium + BAP (5.0 µM/L) + IBA (1.0 µM/L)	½ MS+ IBA (150 µM/L)	Shoot multiplication and Rooting	91
Thyrsostachysoliveri	Liquid MS+BAP (1 mg/L)	MS+ BAP (1.0-5.0 mg/L)	½ MS + NAA (3.0 mg/L)/ IBA (5.0 mg/L)	Shoot multiplication and Rooting	112

Contamination: Bottleneck for culture establishment

Surface and systemic contamination is the major incidence in tissue culture of bamboo because it has large intercellular spaces and vessel cavities at the cut end which accumulated contaminating agents deeply. Therefore, various bacterial and fungal contaminations have been serious problems obtained in bamboo *in vitro* culture. According to Ramirez et al. (2009), several bacteria like *Xanthomonas, Pseudomonas, Agrobacterium and Erwinia* and *Bacillus sp*. by Cruz- Martin et al. (2007) are contaminating agents in some species of bamboo tissue culture while *Pantoea agglomerans* and *P. ananatis* by Nadha et al. (2012) are the main bacterial contaminates in the nodal segments of *G. angistifolia*. To overcome this problem, there is either incorporation of antibiotics in media or explants treatment in antifungal. Surface sterilization of all pieces of equipment including explants has been done with care to escape contamination [35-40]. Yasodaha et al. (2008) have used Streptomycin and Kanamycin during the culture initiation stages. The combinations of Bavistin with streptomycin [55], streptomycin sulphate and tetracycline hydrochloride [68], bacteriocin [88] gentamycin [89] are used successfully to reduce contamination. When there is not directly used of tap water for washing explants during surface sterilization, it helps to minimize the contamination [38]. Bavistine (Cardazamine) and Mancozebas antifungal and Gentamycin as antibacterial [25, 41-45] are used as anti infections. Also, Ali et al. (2009) have been found that the combination of the antibiotics streptomycin, rifampicin and ciprofloxacin with the fungicide Bavistine is successfully disinfecting in the micropropagation of nodal explants of *B. tulda*, *B. balcooa*, *B. bamboos,* and *D. asper*. Oprin et al. (2004) found that rinsing explants with acetone for 3-4 times with a bleaching solution help to disinfect the explants. During surface sterilization of the explants, it is useful to apply the pre-treatment technique with the combination of the standard disinfected compounds. It is proved by Jimenez et al. (2006) when they pretreated the explants in Extran, Agri-mycine, and benomyl before surface sterilization in sodium hypochlorite and plant preservative mixture. The contamination was reduced from 2% to 11% in *Gaudua angustifolia*. Ramanayake et al. (1995) have suggested that it can be controlled systemic fungal contamination in *B. vulgaris* by supplement of benomyl in the culture medium.

Similarly, the other major problem for the bamboo *in vitro* propagation is browning and necrosis of the shoots in the initiation of culture, shooting stage and rooting stage due to phenolic compounds exudation [25] and increase the production of polyphenol oxidase by wounding of the tissue. It converts browning into blackish, and later on, it dies because the increased production of polyphenol is phytotoxic to the explants [45]. According to Huang et al. (2002) and Oprins et al. (2004), the browning of the plants depends on the species, age and position of the tissue, age of mother plants, the season of explants collection, used nutrient media and used sterilizing agents. Because of the exudation phenolic compound by the plant itself, there was encounter browning problem during shoots multiplication which decreased the multiplication rate. But Huang et al. (2002) observed that the browning of bamboo is in higher pH values of 7 and 8 while in the acidic nutrient media with standard pH 5.7 has a relatively low browning rate. Such a problem is solved by the supplement of some additives along with plant growth regulators in the media [46]. The browning is occurred according to species, tissue or organ, and nutrient medium *in vitro* [47]. Different types of antioxidants (Ascorbic acid, Cysteine, Activated Charcoal, Citric acid, Adenine sulphate, Polyvinylpyrrolidone (PVP)) with various concentrations are either substituted into the media reduced the browning problem or soaking the explants in a liquid solution of those mentioned [73,74] to reduce the browning percentage in multiple shoots. Waikhom and Louis (2014) have shown that the addition of NaCl and Silicon in MS media significantly enhances the activities of antioxidant enzymes. But some researchers have succeeded to overcome serious browning and leaching problem by frequently transfer the clumps to the fresh medium without the incorporation of any antioxidants with media and treatments [74]. Huang et al. (2002) found in *B. oldhamii, D. latiflorus,* and *P. nigra* browning control when they used PVP, activated charcoal, ascorbic acid, cysteine, ferulic acid, and thiourea.

Shoot Multiplication

The size and number of propagules have a vital role in the shoot multiplication. Three to four propagules for each culture to multiply was observed effective

[29-31] than individual propagule cultured [38]. Furthermore, BAP was extensively used on *in vitro* multiplication of different bamboos shoot [86, 87, 124]. A higher concentration of BAP was an impact on decreasing numbers and length of shoots. KN alone is not a significant response in shoot multiplication in *B. balcooa*, which results in the clumps dried and browning. Incorporation between KN and BAP was found effective in shoot multiplication [88]. Similar to the synergistic effect of KN and BA on the shoot multiplication rate was reported in *B. balcooa* [59]; *B. glaucescens* [89]; *D. giganteus* [40]; *B .tulda* and *M. baccifera* [38]. Similarly, TDZ has been reported an effective cytokinin for shoot proliferation [82, 90]. The effect of coconut water on bamboo shoot multiplication has been reported by different researchers. Saxena and Bhojwani (1993) have found that the addition of 10% coconut milk (CM) as an additive in the media is better for shoot proliferation and multiplication in *D. giganteus*. Ramanayake et al. (2001) reported that a high level of sucrose (4%) adversely affected the shoot multiplication in *D. giganteus*. There are 3% sucrose is widely used in tissue culture.

Devi and Sharma (2009) have found IBA was superior over NAA for shoot multiplication in *Arundinaria callosa* Munro. The use of IAA and NAA in conjunction with BA and KN was found to increase the length of shoots but lowered the multiplication rate [29]. Further, Gibberellic acid (GA) was effective and enhances for multiplication of shoot in *B. vulgaris* [63]. Rathore et al. (2009) only one researcher who has accounted for that the combined effect of NAA and BAP was effective for shoot multiplication of *B. balcooa and B. bambos*.

Rooting

In vitro rooting is the bottleneck for the researchers in bamboo. Generally, NAA, IAA, and IBA are used individuals or combined for root initiation. These three hormones were more suitable for rooting in *D. asper* [84, 91,92,93,94, 97, and 98]. Clusters of 3-5 shoots were effective for transferring into rooting medium [29, 51, 58, 96, 99, 123, 124]. Full strength MS and half-strength MS media with the supplement of rooting hormones were frequently practiced for *In vitro* rooting. Arya et al. (2008) reported 80-90% of roots obtained in MS medium with supplementing of NAA or IBA within 5 weeks of transferring while working in *D. asper* and *D. falcatum*. But Singh et al. (2012b) have observed that 100% rooting in *D. asper* by using a combination of IBA and NAA. Whereas for *B. tulda* and *B. balcooa* a two-step treatment of 7 days on liquid MS medium supplemented with IBA and then transferred *in vitro* shoots to basal MS medium (pulse treatment) without any rooting hormones, was followed for *in vitro* rooting [43]. The combination of IBA and NAA for rooting has been also reported by Islam and Rahman (2005); Arya et al. (2006) and Rathore et al. (2009) in many important bamboo species. Some studies proved that IBA was found to be the most favorable root inducer compared to NAA and IAA on several bamboos such as *Drepanostachym falcatum* [40], *Oxytenanthera abyssinica* [94], *D. hookeri* [95], *D. hamiltonii* [92]); *Melocanna baccifera* [100]. On rooting medium shoots also elongated and good root and shoot system developed in 5-7 weeks. Saxena (1990) working on *B. tulda* has reported supplementing of Coumarin in rooting media resulted in better root induction and elongation. Similarly, Ramanayake and Yakandwala (1997) working on *D. giganteus* and Sood et al. (2009) on *D. hamiltonii* observed a high frequency of rooting when IBA was used in combination with Coumarin. In the case of *D. strictus*, up to 90%, rooting was found in medium containing IBA [38].

However, well-developed roots with healthy shoots were observed in half-strength MS medium supplemented with NAA [36]. Negi and Saxena (2011) have a document that the highest rooting frequency was obtained on ½ MS media with supplemented of IAA, IBA and NAA in *B. nutans* and also similar result obtained by Kapoor and Rao (2006) who reported that 100% rooting in ½ MS media containing the optimal concentration of BA and NAA in *B. bambos*. Sanjaya et al. (2005) have achieved *In vitro* rhizome in *P. stocksii* with continued subculturing of rooted plantlets on medium containing ½ strength of Major salts within the addition of IBA, BA, ascorbic acid, citric acid, cysteine and glutamine in different concentration. Chowdhury et al. (2004) obtained *in vitro* rhizome in *D. strictus* culturing in rooting media that have ½ strength major salts and IBA. Again, several researchers observed half-strength MS supplemented with NAA and IBA was better than that of the full strength of MS media [21, 25, 29, 78] in various bamboo species. Islam and Rehman (2005) have accounted that the couple of NAA and IBA

were suitable for the rooting of bamboo. But IBA was found better than NAA in *B. arundinacea* and *D. giganteus* for rooting by. Again, the IBA supplemented medium showed only poorly developed roots in *B.nutans* and *B. balcooa* [29]. But Ravikumar et al. (1998) reported that IBA supplement in MS media was more effective to root induction in *D. strictus* and *D. asper* respectively which was also supported by Bag et al. (2000) in the result of *Thamnocalamus spathiflorus*. Singh et al. (2012b) reported that the combination of IBA and NAA was a synergistic effect for rooting in *D. asper* in place of single use. But Mudoi and Borthakur (2009) observed a combination of NAA and BAP was found most effective in rooting of *B. balcooa* which was also confirmed by Goyal et al. (2015) in *D. strictus*. The limited number of the report was available for rooting in IAA. Kapruwan et al. (2014) reported IAA for *in vitro* rooting in *D. strictus*. The effect of growth regulators on rooting was varied species to species [95]. Negi and Saxena (2011) have practiced successfully rooting in full strength MS liquid media with the supplement of IAA, IBA, and NAA. And the high concentration of cytokine introduced for rooting might have resulted in cell death and cell cultures became yellowing leaves and reduced root mass in intact plants [97-100].

Hardening

The transfer of *in vitro* propagated plantlets form Lab to land is another big nutshell of micro-propagation [22]. The plant developed *in vitro* is unable to survive *in vivo* directly due to lack of adaptation and proper hardening [43] however it has well-developed roots. To overcome the bottleneck of hardening, researchers have followed various hardening procedures. In general, the healthy and well-rooted plantlets are washed to free from the rooting medium and transferred to the pot containing growth supporting composition such as soil, sand, soil rite, perlite, cocopeat, agro peat, vermiculite, compost, farmyard manure, etc either alone or in various ratios [22]. Most researchers have used mention substrate in 1:1:1 ratio or modified. Some researchers have described the primary hardening and secondary hardening to obtained maximum numbers of plantlets. Like, *In vitro* plantlets were transferred to ½ strength MS liquid medium without plant growth regulators and vitamins for hardening in *D. asper* [65], *B. nutans* [109], and *D. hamiltonii* [54]. Then when plantlets transferred to polybags 1:1:1 composition of Sand: Farmyard manure: Soil they obtained high rate plantlets. The mortality percentage of plants is increased when the direct transfer of *in vitro* propagated plantlets to the external environment because of their inability to survive against biotic and abiotic stresses [91]. But Negi and Saxena (2011) obtained a 95.83% success rate by directly hardening in 2:1 mixture of soil: agro peat in *B. nutans*. Similarly, several workers reported on hardening of *in vitro* plants in the mixture of soil: sand: compost cocopeat (1:1:1) in *B.nutans* [87, 110]; soil: sand: cow dung(1:1:2) in *B. balcooa* [25] and *B. nutans* (Sharma and Sarma2014); soil mixture of peat, perlite, and vermiculite (1:1:1) in *B. oldhamii* [77], perlite, soil, and farmyard manure (1:1:1) in *D. strictus* [36]; 3:1 ratio of coco peat and vermicompost (3:1) in *B. balcooa* [43]. Without other substrates composition with soil, *In vitro* plantlet was acclimatized successfully in *B. bambos* [22, 29, 33, 41, 42, 62, 65]

BA- 6- Benzyl Adenine, BAP- 6- Benzyl aminopurine, TDZ- Thidiazuron, IBA- Indole -3-butyric acid, IAA- Indole -3-acetic acid, NAA- α-Naphthalene acetic Acid, Ads- Adenine sulphate, KN- Kinetin, MS-Murrashige and Skoog media, CW-Coconut water.

Conclusion

As a fast-growing and high potential economic development of the country, the demanding bamboo has enhanced the depleting rootstock of bamboo rapidly. Bamboo has a high capacity to carbon sequester and it is the mitigation of climate change and environments. Similarly, it is an alternative source of the forest. So that it has a great role in conservation biology and is become a priority concern. With knowledge of the awareness of the conservation biology and environment however people have to fulfill the enormous demands of the markets, they have to exploit the limited resources. Harvesting from the resources means that a large scale of bamboo plantlets are necessary highly through micropropagation to fill up the gap of plant stocks. Mass yield production protocols along with factors influence on it are discussed in the review. Several protocols are reported by several researchers. Nodal explants are better explants for micropropagation technique with the supplement of proper plant growth regulators in MS media at

decontamination condition, the proper season of explants collection, and appropriate position of the nodal segment in mother plant stocks. BA/ BAP is the best cytokine for bud initiation and shoots multiplication bamboo species. *In vitro* rooting is specific for bamboo species. IBA is a more effective rooting hormone for bamboo in comparison to other NAA and IAA. But several studies indicated that a couple of IBA and NAA is also effective for rooting in *in vitro*. It is also reported that the incorporation of NAA, IBA, and IAA is also suitable for rooting in some bamboo species. Sand alone is restricted for hardening but the combination of different substrates varies, the ratio is appreciable for hardening the *in vitro* rooted plants. The more relevant protocols have to develop by addressing those issues properly. Future research must be focused to generate a large scale of bamboo plants.

Author's Contribution

MMS, JL and DPG were equally contributed to preparing framework of literature, conceptualization, Review and editing the final draft. MMS was involved in writing original draft of this review article. JL was Project coordinator and DPG was Project in charge. All authors read and approved the final manuscript.

Competing Interest

The authors declare that they have no competing interest, which includes personal, financial, or any other kind of relationship with people or organizations that could inappropriately affect this review.

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Abbreviations

Benzyl amino purine (BAP), 6 –Benzyl adenine (BA), Naphthalene Acetic acid (NAA), Indole 3-Butyric acid (IBA), Indole Acetic acid (IAA), Zeatin (ZN), Kinetin (KN), Thidiazurn (TDZ), MS (Murashige and Skoog), Plant Growth Regulators PGRs, Coconut Water (CW), Adenine Sulphate (Ads) etc.

References

1. Godbole S, Sood A, Thakur R, Sharma M, Ahuja PS. Somatic embryogenesis and its conversion into plantlets in a multipurpose bamboo, *Dendrocalamus hamiltonii* Nees et Arn. Ex Munro. Current science. 2002 Oct 10:885-9.
2. Kumar V, Banerjee M. Albino regenerants proliferation of *Dendrocalamus asper* in vitro. World Journal of Agricultural Sciences. 2014;10(1):09-13.
3. Grass Phylogeny Working Group, Barker NP, Clark LG, Davis JI, Duvall MR, Guala GF, Hsiao C, Kellogg EA, Linder HP, Mason-Gamer RJ, Mathews SY. Phylogeny and subfamilial classification of the grasses (Poaceae). Annals of the Missouri Botanical Garden. 2001 Jul 1:373-457. https://doi.org/10.2307/3298585
4. Clark LG, Londoño X, Ruiz-Sanchez E. Bamboo taxonomy and habitat. InBamboo 2015 (pp. 1-30). Springer, Cham. https://doi.org/10.1007/978-3-319-14133-6_1
5. Kigomo BN. Guidelines for Growing Bamboo. KEFRI Guideline Series: No. 4. Kenya Forestry Research Institute (KEFRI). Downtown Printing Works Ltd. Nairobi, Kenya. 59pp. 2007.
6. Mudoi KD, Saikia SP, Goswami A, Gogoi A, Bora D, Borthakur M. Micropropagation of important bamboos: a review. African Journal of Biotechnology. 2013;12(20).
7. Banik RL. Review of conventional propagation research in bamboos and future strategy. INBAR. 1994;5:115-42.
8. Banik RL. Selection criteria and population enhancement of priority bamboos. INBAR. 1995 May;7:99-110.
9. Banik RL. Bamboo silviculture. InBamboo 2015 (pp. 113-174). Springer, Cham. https://doi.org/10.1007/978-3-319-14133-6_5
10. FAO F. Agriculture Organization: Global Forest Resources Assessment. FAO, Rome, Italy. 2010.
11. BPG (Bamboo Phylogeny Group). An updated tribal and subtribal classification of the bamboos (Poaceae: *Bambusoideae*). In: Proceedings of the 9th World Bamboo Congress. Antwerp, Belgium: World Bamboo Organization. 2012;3-27.
12. Soreng RJ, Peterson PM, Romaschenko K, Davidse G, Zuloaga FO, Judziewicz EJ, Filgueiras TS, Davis JI, Morrone O. A worldwide phylogenetic classification of the Poaceae (Gramineae). Journal of Systematics and Evolution. 2015 Mar;53(2):117-37. https://doi.org/10.1111/jse.12150
13. Bystriakova N, Kapos V, Lysenko I, Stapleton CM. Distribution and conservation status of forest bamboo biodiversity in the Asia-Pacific Region. Biodiversity & Conservation. 2003 Sep 1;12(9):1833-41. https://doi.org/10.1023/A:1024139813651
14. Shrestha K. Distribution and status of bamboos in Nepal. Natural History Museum, Plant Department, Nepal. 2001.
15. Bhattacharya S, Ghosh JS, Sahoo DK, Dey N, Pal A. Screening of superior fiber-quality-traits among wild accessions of *Bambusa balcooa*: efficient and non-invasive evaluation of fiber developmental stages. Annals of Forest Science. 2010 Jan;67(6):611 https://doi.org/10.1051/forest/2010024
16. Hsiung W. Prospects for bamboo development in the world. Journal de La American Bamboo Society. 1988;8(1-2):168.
17. Benton A, Thomson L, Berg P, Ruskin S. Bamboo (various species). Farm And Forestry Production And Marketing. 2011.
18. Gantait S, Pramanik BR, Banerjee M. Optimization of planting materials for large scale plantation of *Bambusa balcooa* Roxb.: Influence of propagation methods. Journal of the Saudi Society of Agricultural Sciences. 2018 Jan 1;17(1):79-87. https://doi.org/10.1016/j.jssas.2015.11.008
19. Tewari DN. Silviculture and management of bamboos in India. A monograph on bamboo. International Book Distributors, Dehra Dun. 1992:169-86.
20. Austin AT, Marchesini VA. Gregarious flowering and death of understorey bamboo slow litter decomposition and nitrogen turnover in a southern temperate forest in Patagonia,

Argentina. Functional Ecology. 2012 Feb;26(1):265-73. https://doi.org/10.1111/j.1365-2435.2011.01910.x
21. Singh SR, Singh R, Kalia S, Dalal S, Dhawan AK, Kalia RK. Limitations, progress and prospects of application of biotechnological tools in improvement of bamboo-a plant with extraordinary qualities. Physiology and Molecular Biology of Plants. 2013 Jan 1;19(1):21-41. https://doi.org/10.1007/s12298-012-0147-1
22. Embaye K. Ecological aspects and resource management of bamboo forests in Ethiopia. 2003.
23. Haile B. Study on establishment of bamboo processing plants in Amhara Regional State. Addis Ababa University. 2008.
24. Singh J, Sharma R, Dhakad AK, Chauhan SK. Defining growth, quality and biomass production of different bamboo species in central plains of Punjab. Journal of Pharmacognosy and Phytochemistry. 2018;7(5):1328-32.
25. Arya S, Satsangi R, Arya ID. Large scale plant production of edible bamboo *Dendrocalamus asper* through somatic embryogenesis. Bamboo Science & Culture. 2008 Jun 1;21(1).
26. Ray SS, Ali MN. Factors influencing micropropagation of bamboo species using nodal explants: A review. Research Journal of Pharmaceutical Biological and Chemical Sciences. 2016 Sep 1;7(5):2877-89.
27. Viswanath S. Dendrocalamus stocksii (Munro.): A potential multipurpose bamboo species for Peninsular India. Institute of Wood Science and Technology; 2013.
28. Saxena S, Bhojwani SS. *In vitro* clonal multiplication of 4-year-old plants of the bamboo, *Dendrocalamus longispathus* Kurz. *In Vitro* Cellular & Developmental Biology-Plant. 1993 Jul 1;29(3):135-42. https://doi.org/10.1007/BF02632285
29. Mudoi KD, Saikia SP, Borthakur M. Effect of nodal positions, seasonal variations, shoot clump and growth regulators on micropropagation of commercially important bamboo, Bambusa nutans Wall. ex. Munro. African Journal of Biotechnology. 2014;13(19):1961-72. https://doi.org/10.5897/AJB2014.13659
30. Singh SR, Singh R, Kalia S, Dalal S, Dhawan AK, Kalia RK. Limitations, progress and prospects of application of biotechnological tools in improvement of bamboo-a plant with extraordinary qualities. Physiology and Molecular Biology of Plants. 2013 Jan 1;19(1):21-41. https://doi.org/10.1007/s12298-012-0147-1
31. Kapruwan S, Bakshi M, Kaur M. Rapid *in vitro* propagation of the solid bamboo, *Dendrocalamus strictus* nees, through axillary shoot proliferation. Biotechnology International. 2014;7(3):58-68.
32. Gillis K, Gielis J, Peeters H, Dhooghe E, Oprins J. Somatic embryogenesis from mature *Bambusa balcooa* Roxburgh as basis for mass production of elite forestry bamboos. Plant Cell, Tissue and Organ Culture. 2007 Nov 1;91(2):115-23. https://doi.org/10.1007/s11240-007-9236-1
33. Jiménez VM, Castillo J, Tavares E, Guevara E, Montiel M. *In vitro* propagation of the neotropical giant bamboo, *Guadua angustifolia* Kunth, through axillary shoot proliferation. Plant Cell, Tissue and Organ Culture. 2006 Sep 1;86(3):389-95. https://doi.org/10.1007/s11240-006-9120-4
34. Negi D, Saxena S. *In vitro* propagation of *Bambusa nutans* Wall. ex Munro through axillary shoot proliferation. Plant Biotechnology Reports. 2011 Jan 1;5(1):35-43. https://doi.org/10.1007/s11816-010-0154-z
35. Negi D, Saxena S. Micropropagation of *Bambusa balcooa* Roxb. through axillary shoot proliferation. *In Vitro* Cellular & Developmental Biology-Plant. 2011 Oct;47(5):604-10. https://doi.org/10.1007/s11627-011-9403-2
36. Devi WS, Bengyella L, Sharma GJ. *In vitro* seed germination and micropropagation of edible bamboo *Dendrocalamus giganteus* Munro using seeds. Biotechnology. 2012 Mar 1;11(2):74-80. https://doi.org/10.3923/biotech.2012.74.80
37. Oprins J, Grunewald W, Gillis K, Delaere P, Peeters H, Gielis J. Micropropagation: a general method for commercial bamboo production. InWorld Bamboo Congress 2004 (Vol. 7, pp. 1-11).
38. Thakur R, Sood A. An efficient method for explant sterilization for reduced contamination. Plant Cell, Tissue and Organ Culture. 2006 Mar;84(3):369-71. https://doi.org/10.1007/s11240-005-9034-6
39. Yuan JL, Yue JJ, Wu XL, Gu XP. Protocol for callus induction and somatic embryogenesis in Moso bamboo. PloS one. 2013 Dec 11;8(12):e81954. https://doi.org/10.1371/journal.pone.0081954
40. Sood A, Nadha HK, Sood S, Walia S, Parkash O. Large scale propagation of an exotic edible bamboo, *Phyllostachys pubescens* Mazel ex H. De Lehale (Moso Bamboo) using seeds. Indian J Exp Biol. 2014;52:755-758.
41. Prutpongse P, Gavinlertvatana P. *In vitro* micropropagation of 54 species from 15 genera of bamboo. Hort Science. 1992 May 1;27(5):453-4. https://doi.org/10.21273/HORTSCI.27.5.453
42. Malini N, Anandakumar CR. Micropropagation of bamboo (*Bambusa vulgaris*) through nodal segment. Int J Forest Crop Improv. 2013;4:36-9.
43. Sandhu M, Wani SH, Jiménez VM. *In vitro* propagation of bamboo species through axillary shoot proliferation: a review. Plant Cell, Tissue and Organ Culture (PCTOC). 2018 Jan 1;132(1):27-53. https://doi.org/10.1007/s11240-017-1325-1
44. Goyal AK, Pradhan S, Basistha BC, Sen A. Micropropagation and assessment of genetic fidelity of *Dendrocalamus strictus* (Roxb.) nees using RAPD and ISSR markers. 3 Biotech. 2015 Aug 1;5(4):473-82. https://doi.org/10.1007/s13205-014-0244-7
45. Chowdhury P, Das M, Sikdar SR, Pal A. Influence of the physiological age and position of the nodal explants on micropropagation of field-grown *Dendrocalamus strictus* Nees. Plant Cell Biotechnology and Molecular Biology. 2004 Mar 31;5(1-2):45-50.
46. Waikhom SD, Louis B. An effective protocol for micropropagation of edible bamboo species (*Bambusa tulda* and *Melocanna baccifera*) through nodal culture. The Scientific World Journal. 2014 May;2014. https://doi.org/10.1155/2014/345794
47. Mishra Y, Patel PK, Yadav S, Shirin F, Ansari SA. A micropropagation system for cloning of *Bambusa tulda* Roxb. Scientia Horticulturae. 2008 Feb 1;115(3):315-8. https://doi.org/10.1016/j.scienta.2007.10.002
48. Arya S, Kant A, Sharma D, Arya ID. Micropropagation of Two Economically Important Bamboos: *Drepanostachyum falcatum* (NEES) Keng and *Bambusa balcooa* Roxb. Indian Forester. 2008 Sep 1;134(9):1211-21.
49. Anand M, Brar J, Sood A. *In vitro* propagation of an edible bamboo Bam-busa Bambos and assessment of clonal Fidelity through molecular markers. Journal of Medical and Bioengineering Vol. 2013 Dec;2(4). https://doi.org/10.12720/jomb.2.4.257-261
50. Oka GM, Triwiyono A, Awaludin A, Siswosukarto S. Effects of node, internode and height position on the mechanical properties of *Gigantochloa atroviolacea* bamboo. Procedia Engineering. 2014 Jan 1;95:31-7. https://doi.org/10.1016/j.proeng.2014.12.162
51. Patel B, Gami B, Patel N, Bariya V. One step pre-hardening micropropagation of *Bambusa balcooa* Roxb. Journal of Phytology. 2015 Nov 10:1-9. https://doi.org/10.5455/jp.2015-06-02
52. Ganesan M, Jayabalan N. Carbon source dependent somatic embryogenesis and plant regeneration in cotton, *Gossypium hirsutum* L. cv. SVPR2 through suspension cultures. I J Exp Biol. 2005;43:921-925.
53. Huang LC, Lee YL, Huang BL, Kuo CI, Shaw JF. High polyphenol oxidase activity and low titratable acidity in browning bamboo tissue culture. *In Vitro* Cellular & Developmental Biology-Plant. 2002 Jul 1;38(4):358. https://doi.org/10.1079/IVP2002298

54. Kant A, Arya S, Arya ID. Micropropagation protocol for *Melocanna baccifera* using nodal explants from mature clump. In8th World Bamboo Congress, Thailand 2009 (pp. 2-12).
55. George EF, Hall MA, De Klerk GJ. Plant propagation by tissue culture 3rd Edition. The Netherland, The Back Ground Springer. 2008.
56. Chaturvedi HC, Sharma M, Sharma AK. *In vitro* regeneration of *Dendrocalamus strictus* Nees through nodal segments taken from field-grown culms. Plant science. 1993 Jan 1;91(1):97-101. https://doi.org/10.1016/0168-9452(93)90192-3
57. Bisht P, Pant M, Kant A. *In vitro* propagation of *Gigantochloa atroviolaceae* Widjaja through nodal explants. J Am Sci. 2010;6:1019-26.
58. Mehta R, Sharma V, Sood A, Sharma M, Sharma RK. Induction of somatic embryogenesis and analysis of genetic fidelity of *in vitro*-derived plantlets of *Bambusa nutans* Wall., using AFLP markers. European Journal of Forest Research. 2011 Sep 1;130(5):729-36. https://doi.org/10.1007/s10342-010-0462-4
59. Nadha HK, Rahul K, Sharma RK, Anand M, Sood A. *In vitro* propagation of *Dendrocalamus asper* and testing the clonal fidelity using RAPD and ISSR markers. International Journal of Current Research. 2013;5(8):2060-7.
60. Kiran A, Ansari SA. Adventitious rhizogenesis in relation to seasonal variation, size of culm branch cuttings and IAA treatment in bamboos. Indian forester. 2000;126(9):971-84.
61. Mudoi KD, Borthakur M. *In vitro* micropropagation of *Bambusa balcooa* Roxb. through nodal explants from field-grown culms and scope for upscaling. Current science. 2009 Apr 10:962-6.
62. Singh SR, Dalal S, Singh R, Dhawan AK, Kalia RK. Micropropagation of *Dendrocalamus asper* {Schult. & Schult. F.} Backer ex k. Heyne): an exotic edible bamboo. Journal of Plant Biochemistry and Biotechnology. 2012 Jul 1;21(2):220-8. https://doi.org/10.1007/s13562-011-0095-9
63. Sivabalan S, Ramkumar P. Detection of albino in micropropagated shoots of *Bambusa balcooa* Roxb, using PCR based techniques. International Journal of Engineering Research. 2014 Mar;3(3).
64. Ramanayake SM, Yakandawala K. Micropropagation of the giant bamboo (*Dendrocalamus giganteus* Munro) from nodal explants of field grown culms. Plant Science. 1997 Nov 21;129(2):213-23. https://doi.org/10.1016/S0168-9452(97)00185-4
65. Rathore TS, Rai VR. Micropropagation of *Pseudoxytenanthera stocksii* Munro. *In Vitro* Cellular & Developmental Biology-Plant. 2005 May 1;41(3):333-7. https://doi.org/10.1079/IVP2004625
66. Singh SR, Dalal SU, Singh RO, Dhawan AK, Kalia RK. Seasonal influences on *in vitro* bud break in *Dendrocalamus hamiltonii* Arn. ex Munro nodal explants and effect of culture microenvironment on large scale shoot multiplication and plantlet regeneration. Indian J Plant Physiol. 2012;17:9-21.
67. Das M, Pal A. *In vitro* regeneration of *Bambusa balcooa* Roxb.: factors affecting changes of morphogenetic competence in the axillary buds. Plant cell, tissue and organ culture. 2005 Apr 1;81(1):109-12. https://doi.org/10.1007/s11240-004-3017-x
68. Gantait S, Mandal N, Nandy S. Advances in micropropagation of selected aromatic plants: a review on vanilla and strawberry. Am J Biochem Mol Biol. 2011;1(1):1-9. https://doi.org/10.3923/ajbmb.2011.1.19
69. Nayak S, Hatwar B, Jain A. Effect of cytokinin and auxins on meristem culture of *Bambusa arundinacea*. Der Pharmacia Letter. 2010;2(1):408-14.
70. Devi WS, Sharma GJ. *In vitro* propagation of Arundinaria callosa Munro-an edible bamboo from nodal explants of mature plants. The Open Plant Science Journal. 2009 Jul 2;3(1). https://doi.org/10.2174/1874294700903010035
71. Hirimburegama K, Gamage N. Propagation of *Bambusa vulgaris* (yellow bamboo) through nodal bud culture. Journal of Horticultural Science. 1995 Jan 1;70(3):469-75. https://doi.org/10.1080/14620316.1995.11515317
72. Sood A, Ahuja PS, Sharma M, Sharma OP, Godbole S. *In vitro* protocols and field performance of elites of an important bamboo *Dendrocalamus hamiltonii* Nees et Arn. Ex Munro. Plant Cell, Tissue and Organ Culture. 2002 Oct 1;71(1):55-63. https://doi.org/10.1023/A:1016582732531
73. Arya ID, Satsangi R, Arya S. Rapid micropropagation of edible bamboo *Dendrocalamus asper*. Journal of Sustainable Forestry. 2001 Aug 28;14(2-3):103-14. https://doi.org/10.1300/J091v14n02_06
74. Jha A, Das S, Kumar B. Micropropagation of *Dendrocalamus hamiltonii* through nodal explants. Global Journal of Bio-Science and Biotechonolgy. 2013;2(4):580-2.
75. Pandey BN, Singh NB. Micropropagation of *Dendrocalamus strictus* nees from mature nodal explants. Journal of Applied and Natural Science. 2012 Jun 1;4(1):5-9. https://doi.org/10.31018/jans.v4i1.213
76. Raju RI, Roy SK. Mass propagation of *Bambusa bambos* (L.) Voss through *in vitro* culture. Jahangirnagar University Journal of Biological Sciences. 2016;5(2):15-26. https://doi.org/10.3329/jujbs.v5i2.32514
77. Cheah KT, Chaille LC. Somatic embryogenesis from mature *Bambusa ventricosa*. College of Tropical Agriculture and Human Resources, University of Hawaii. 2011.
78. Wei Q, Cao J, Qian W, Xu M, Li Z, Ding Y. Establishment of an efficient micropropagation and callus regeneration system from the axillary buds of *Bambusa ventricosa*. Plant Cell, Tissue and Organ Culture (PCTOC). 2015 Jul 1;122(1):1-8. https://doi.org/10.1007/s11240-015-0743-1
79. Arya ID, Arya S. *In vitro* shoot proliferation and somatic embryogenesis: means of rapid bamboo multiplication. In10th World Bamboo Congress, Propagation, Plantation and Management, Korea 2015.
80. Arshad SM, Kumar A, Bhatnagar SK. Micropropagation of *Bambusa wamin* through shoot proliferation of mature nodal explants. Journal of Biological Research. 2005;3:59-66.
81. Saxena S. *In vitro* propagation of the bamboo (*Bambusa tulda* Roxb.) through shoot proliferation. Plant cell reports. 1990 Dec 1;9(8):431-4. https://doi.org/10.1007/BF00232266
82. Das M, Pal A. Clonal propagation and production of genetically uniform regenerants from axillary meristems of adult bamboo. Journal of Plant biochemistry and biotechnology. 2005 Jul 1;14(2):185-8. https://doi.org/10.1007/BF03355956
83. Murashige T, Skoog F. A revised medium for rapid growth and bio assays with tobacco tissue cultures. Physiologia plantarum. 1962 Jul;15(3):473-97. https://doi.org/10.1111/j.1399-3054.1962.tb08052.x
84. García-Ramírez Y, Gonzáles MG, Mendoza EQ, Seijo MF, Cárdenas ML, Moreno-Bermúdez LJ, Ribalta OH. Effect of BA treatments on morphology and physiology of proliferated shoots of *Bambusa vulgaris* Schrad. Ex Wendl in temporary immersion. American Journal of Plant Sciences. 2014 Jan 24;2014. https://doi.org/10.4236/ajps.2014.52027
85. Lin CS, Kalpana K, Chang WC, Lin NS. Improving multiple shoot proliferation in bamboo mosaic virus-free *Bambusa oldhamii* Munro propagation by liquid culture. Hortscience. 2007 Aug 1;42(5):1243-6. https://doi.org/10.21273/HORTSCI.42.5.1243
86. Kavitha B, Kiran S. An Efficient Technique for *in vitro* propagation of *Dendrocalamus Brandisii* Kurz using Nodal Segments. Global Journal of Microbiology and Biotechnology. 2014;2(1):1-0.
87. Somashekar PV, Rathore TS, Shashidhar KS. Rapid and simplified method of micropropagation of *Pseudoxytenanthera stocksii*. Ansari SA, Narayanan C, Mandal AK. Forest biotechnology in India. Delhi: Satish serial publishing house. 2008:165-82.
88. Sharma P, Sarma KP. *In vitro* propagation of *Bambusa balcooa* for a better environment. InInternational Conference on

Advances in Biotechnology and Pharmaceutical Sciences. Bangkok: Planetary Scientific Research Centre 2011 Dec (pp. 248-252).
89. Pratibha S, Sarma KP. *In vitro* propagation of *Bambusa tulda*: An important plant for better environment. Journal of Environmental Research and Development. 2013 Jan;7:1216-23.
90. Pratibha S, Sarma KP. *In vitro* propagation of *Bambusa nutan* in commercial scale in assam, India. Journal of Environmental Research and Development. 2014 Oct 1;9(2):348..
91. Bag N, Chandra S, Palni LM, Nandi SK. Micropropagation of Dev-ringal [*Thamnocalamus spathiflorus* (Trin.) Munro]-a temperate bamboo, and comparison between *in vitro* propagated plants and seedlings. Plant Science. 2000 Jul 28;156(2):125-35. https://doi.org/10.1016/S0168-9452(00)00212-0
92. Bonga JM, Aderkas P, von Aderkas P. *In vitro* culture of trees. Springer Science & Business Media; 1992 May 31. https://doi.org/10.1007/978-94-015-8058-8
93. Venkatachalam P, Kalaiarasi K, Sreeramanan S. Influence of plant growth regulators (PGRs) and various additives on *in vitro* plant propagation of *Bambusa arundinacea* (Retz.) Wild: A recalcitrant bamboo species. Journal of Genetic Engineering and Biotechnology. 2015 Dec 1;13(2):193-200. https://doi.org/10.1016/j.jgeb.2015.09.006
94. Kalaiarasi K, Sangeetha P, Subramaniam S, Venkatachalam P. Development of an efficient protocol for plant regeneration from nodal explants of recalcitrant bamboo (*Bambusa arundinacea* Retz. Willd) and assessment of genetic fidelity by DNA markers. Agroforestry systems. 2014 Jun 1;88(3):527-37. https://doi.org/10.1007/s10457-014-9716-3
95. Nadgauda RS, Parasharami VA, Mascarenhas AF. Precocious flowering and seeding behaviour in tissue-cultured bamboos. Nature. 1990 Mar;344(6264):335-6. https://doi.org/10.1038/344335a0
96. Tuan TT, Tu HL, Du TX. The increase in *in vitro* shoot multiplication rate of *Dendrocalamus asper* (Schult. f.) Back. ex Heyne. TAP CHI SINH HOC. 2012 Aug 6;34(3se):257-64. https://doi.org/10.15625/0866-7160/v34n3se.1790
97. Yasodha R, Kamala S, Kumar SA, Kumar PD, Kalaiarasi K. Effect of glucose on *in vitro* rooting of mature plants of *Bambusa nutans*. Scientia Horticulturae. 2008 Mar 10;116(1):113-6. https://doi.org/10.1016/j.scienta.2007.10.025
98. Das M, Pal A. *In vitro* regeneration of *Bambusa balcooa* Roxb.: factors affecting changes of morphogenetic competence in the axillary buds. Plant cell, tissue and organ culture. 2005 Apr 1;81(1):109-12. https://doi.org/10.1007/s11240-004-3017-x
99. Shirin F, Rana PK. *In vitro* plantlet regeneration from nodal explants of field-grown culms in *Bambusa glaucescens* Willd. Plant Biotechnology Reports. 2007 Aug 1;1(3):141-7. https://doi.org/10.1007/s11816-007-0020-9
100. Lin CS, Chang WC. Micropropagation of *Bambusa edulis* through nodal explants of field-grown culms and flowering of regenerated plantlets. Plant cell reports. 1998 May 1;17(8):617-20. https://doi.org/10.1007/s002990050453
101. Deb CR, Imchen T. An Efficient *In vitro* Hardening Technique of Tissue Culture Raised Plants. Biotechnology. 2010;9(1):79-83. https://doi.org/10.3923/biotech.2010.79.83
102. Agnihotri RK, Nandi SK. *In vitro* shoot cut: a high frequency multiplication and rooting method in the bamboo *Dendrocalamus hamiltonii*. Biotechnology. 2009;8(2):259-63. https://doi.org/10.3923/biotech.2009.259.263
103. Banerjee M, Gantait S, Pramanik BR. A two step method for accelerated mass propagation of *Dendrocalamus asper* and their evaluation in field. Physiology and Molecular Biology of Plants. 2011 Oct 1;17(4):387. https://doi.org/10.1007/s12298-011-0088-0
104. Diab EE, Mohamed SE. *In Vitro* Morphogenesis And Plant Regeneration Of Bamboos (*Oxytenanthera abyssinica* A. Rich. Munro). Int. J. Sustain. Crop Prod. 2008 Oct;3(6):72-9.
105. Ramanayake SM, Maddegoda KM, Vitharana MC, Chaturani GD. Root induction in three species of bamboo with different rooting abilities. Scientia Horticulturae. 2008 Oct 1;118(3):270-3. https://doi.org/10.1016/j.scienta.2008.06.004
106. Ramanayake SM, Yakandawala K, Nilmini Deepika PK, Ikbal MC. Studies on micropropagation of *Dendrocalamus gigateus* and *Bambusa vulgaris* var. striata. Bamboo, people and the environment. 1995;1:75-85.
107. Rathore TS, Kabade U, Jagadish MR, Somashekar PV, Viswanath S. Micropropagation and evaluation of growth performance of the selected industrially important bamboo species in southern India. InProc 8th World Bamboo Congress, Bankok, Thialand 2009 (pp. 41-55).
108. Ravikumar R, Ananthakrishnan G, Kathiravan K, Ganapathi A. *In vitro* shoot propagation of *Dendrocalamus strictus* nees. Plant cell, tissue and organ culture. 1998 Mar 1;52(3):189-92. https://doi.org/10.1023/A:1006092620731
109. Singh M, Jaiswal U, Jaiswal VS. Thidiazuron-induced shoot multiplication and plant regeneration in bamboo (*Dendrocalamus strictus* Nees). Journal of Plant Biochemistry and Biotechnology. 2001 Jul 1;10(2):133-7. https://doi.org/10.1007/BF03263122
110. Kant A, Arya S, Arya ID. Micropropagation protocol for *Melocanna baccifera* using nodal explants from mature clump. In8th World Bamboo Congress, Thailand 2009 (pp. 2-12).
111. Beena DB, Rathore TS. *In vitro* cloning of *Bambusa pallida* Munro through axillary shoot proliferation and evaluation of genetic fidelity by random amplified polymorphic DNA markers. International Journal of Plant Biology. 2012 Dec 10;3(1):e6-. https://doi.org/10.4081/pb.2012.e6
112. Islam SA, Rahman MM. Micro-cloning in commercially important six bamboo species for mass propagation and at a large scale cultivation. Plant Tissue Cult Biotech. 2005;15:103-11.
113. Ndiaye A, Diallo MS, Niang D, Gassama-Dia YK. *In vitro* regeneration of adult trees of *Bambusa vulgaris*. African Journal of Biotechnology. 2006;5(13).
114. Nissen SJ, Sutter EG. Stability of IAA and IBA in nutrient medium to several tissue culture procedures. HortScience. 1990 Jul 1;25(7):800-2. https://doi.org/10.21273/HORTSCI.25.7.800
115. Ogita S, Kashiwagi H, Kato Y. *In vitro* node culture of seedlings in bamboo plant, *Phyllostachys meyeri* McClure. Plant Biotechnology. 2008 Jun 25;25(4):381-5. https://doi.org/10.5511/plantbiotechnology.25.381
116. Paranjothy K, Saxena S, Banerjee M, Jaiswal VS, Bhojwani SS. Clonal multiplication of woody perennials. InDevelopments in crop science 1990 Jan 1 (Vol. 19, pp. 190-219). Elsevier. https://doi.org/10.1016/B978-0-444-88883-9.50012-1
117. Roy SS, Ali MN, Gantait S, Chakraborty S, Banerjee M. Tissue culture and biochemical characterization of important bamboos. Research Journal of Agricultural Sciences. 2014 Mar;5(2):135-46.
118. Thiruvengadam M, Rekha KT, Chung IM. Rapid *in vitro* micropropagation of *Bambusa oldhamii* Munro. Philippine Agricultural Scientist. 2011;94(1):7-13.
119. Sharma SK, Kalia S, Kalia RK. Rapid In-Vitro Regeneration from 40-Year-old Clump of *Bambusa nutans* wall. Ex Munro. The Journal of Indian Botanical Society. 2012;91(4):365-78.
120. Yasodha R, Kamala S, Kalaiarasi K. Anatomical and biochemical changes associated with *in vitro* rhizogenesis in *Dendrocalamus giganteus*. Journal of Plant Biochemistry and Biotechnology. 2010 Jul 1;19(2):217-22. https://doi.org/10.1007/BF03263343
121. Cruz-Martín M, García-Ramírez Y, Sánchez-García C, Alvarado-Capó Y, Acosta-Suárez M, Roque B, Leiva-Mora M, Freire-Seijo M. Identificación y control de *Bacillus* sp., contaminante del establecimiento *in vitro* de *Guadua angustifolia* Kunth. Biotecnología vegetal. 2007 Jan 5;7(1).
122. Nadha HK, Salwan R, Kasana RC, Anand M, Sood A. Identification and elimination of bacterial contamination

during *in vitro* propagation of *Guadua angustifolia* Kunth. Pharmacognosy magazine. 2012 Apr;8(30):93. https://doi.org/10.4103/0973-1296.96547

123. Chang WC, Ho CW. Micropropagation of bamboos. InHigh-Tech and Micropropagation V 1997 (pp. 203-219). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-07774-0_13

124. Thapa N, Gauchan DP, Suwal MM, Bhuju S, Upreti A, Byanju B, Lamichhane J. *In Vitro* Assessment of *Bambusa balcooa* Roxb. For Micropropagation. Journal of Emerging Technologies and Innovative Research. 2018;5(12).