AN INVESTIGATION INTO MACRO-PROLIFERATION OF SOME SELECTED BAMBOO SPECIES OF ASSAM

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Introduction

India is considered as one of the largest reserves of bamboo in the world. Bamboo, popularly known as giant grass, with more than 1,575 species in the world, occurring in a wide variety of soil and climatic conditions, plays an important role in providing livelihood and ecological security to the mankind. There are about 1,500 traditional uses of bamboo broadly classified into household, industry, weapons, energy, transportation, fisheries, agriculture, medicine and construction. Due to over exploitation of bamboo forests for industrial and commercial purposes the bamboo stock has been gradually decreasing. The depletion of bamboo stock has also had an adverse impact on the rural populations. The shortage of supply of bamboo has been compounded by the absence of adequate re-plantation works on account of non-availability of seed or the planting stock.

Most of the economically important bamboo species flower only at long intervals of 30-40 years and their seeds have short viability of six to eight months and therefore, vegetative propagation is the only option to raise bamboo plantation extensively on regular basis. Vegetatively bamboo can be propagated through rhizomes, offsets, layering, clump cutting, branch cutting, etc. Propagation through techniques like divisions, rhizomes, offsets, layering, etc. yield limited number of plants depending on the size of the mother clump and hence are not appropriate when the objective is to create plantations on larger tracts of the land. Various methods regarding vegetative propagation of bamboo has been described from time to time (Deogun, 1936; Bhatnagar, 1974; Sharma, 1980; Seethalakshmi *et al.,* 1983; Sharma and Kaushal, 1985; Banik 1985; Kumar, 1989).

In order to meet the ever increasing demand of planting stock for raising extensive bamboo plantation and also to study macroproliferation of important bamboo species of Assam, the present study was undertaken at the Silviculture Division, Basistha, Assam for production of bamboo planting stock of some of the important species of Assam vegetatively using two-noded culm cutting with macroproliferation.

Material and Methods

The present study was carried out on six species of bamboo*: Bambusa vulgaris* var *vittata* A. and C. Riviere, *B. bambos* Linn., *B. balcooa* Roxb., *B. nutans.* Wall.

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ex Munro, *B. tulda* Roxb. and *Dendrocalamus hamiltonii* Nees et Arn. ex. Munro for the production of quality planting stock using two noded culm cuttings followed by macro-proliferation method.

The Basistha Silvicultural Centre is located within geographical limits of 26° to 26° 15' E longitude and 91° to 91° 50' N latitude at North-East corner of Gorbhanga Reserve Forest and receives annual rainfall in the range of 1,440 to 2,189 mm with as many as 25 rainy days in the month of July/August. The area has typical moist tropical climate. The mean minimum temperature of the area ranges from 18.7°C to 20.13°C while the mean maximum temperature ranges from 28.82°C to 30.10°C during the year. For few days in a year (in the month of April) the maximum temperature crosses 38°C whereas the lowest temperature dips down to 5°C in the month of January. Generally the months of November, December and January receive least rainfall. The relative humidity in the area is above 70% except in the months of January, March and April.

(a) *Selection of clump and culm* : Healthy non-congested clumps of all the six species were identified from home-grown bamboo plots in Sonapur area near Guwahati during the period March-April 2004. Clumps selected had culms of all the age gradations and had not been operated during last 2-3 years.

(b) *Bed preparation* : Raised nursery beds of 10 m x 1.2 m x 0.5 m were prepared. The bed were filled up with a mixture of soil, sand and farm yard manure in a ratio of 1 : 1 : 1. Ten days prior to the planting all the beds were drenched with insecticide, Haxolin and the fungicide (Bavistin) separately to prevent insect and fungal attack. For each bed, 30 litres of 0.2% Haxolin prepared by adding 2 gm in 1 litre water and 30 litres of 0.1% Bavistin prepared by adding 1 gm in 1 litre was used. After that all the beds were covered with polythene sheet for three days for the purpose of raising temperature to kill the noxious organisms present in the soil mixture.

(c) *Preparation of culm cuttings* : From the identified healthy clumps 1.5 to 2 years old culms were selected and extracted with a sharp instrument leaving atleast 2 nodes at the base. After trimming the leaves and side branches the culms were transported to the nursery site within 2 days of their extraction. From the culms brought to nursery site two noded cuttings (leaving 5-8 cm on either side) were made for putting in nursery beds. At the time of cutting of culms into 2 noded pieces a portion of about 0.5 m to 1 m on bottom side and a portion of about 0.5 m to 1.0 m on top side was not utilized as in these portions the nodes had either damaged or had deformed buds.

(d) *Placing of cuttings* : The two noded cuttings were placed in April 2004 in raised beds horizontally in such a way that the buds were placed laterally. About 25 numbers of cuttings were conveniently planted in one raised nursery bed of 10 m x 1.2 m. Fifty (50) nos. of cuttings of each of the six species were used for the study. After placing the cuttings in the beds they were covered with a thin layer of soil (4 to 5 cm) mixture.

(e) *Maintenance of nursery beds and sprouts* : All the nursery beds were provided with shade to protect the planted cuttings from direct sunlight. Beds were watered regularly in the morning and the evening

and also maintained by regular weeding and soil working. All the newly emerging sprouts were treated with 0.1% Bavistin and 0.1% Haxolin separately at an interval of 15 days to avoid fungal and insect attack.

(f) *Macro-proliferation* : The sprouting, rooting and rhizome formation behaviour from each node of each species was regularly observed on almost daily basis. The macro-proliferation from each node and polypotted propagules was carried out during the period June 2004 to March 2005 at intervals of 2-3 months. At the time of separation of propagules from mother node/ polypotted stock the care was taken to ensure that the segregated propagule comes out with a portion of rhizome with bud and roots as suggested by Banik (1985) while describing the method. The segregated propogules were planted in polypots of the size 24 cm x 18 cm filled with a mixture of sieved soil, sand and vermin-compost in the ratio 1 : 1 : 1. These polypotted propagules were kept under shade and watered regularly. The emergence of new shoots, their rooting and the rhizome enlargement of the polypotted propagules was also observed regularly. The new propagules start sprouting from these polypotted ones within 7-9 days and by the end of 2 months 2-3 separable propagules were found to be available from such polypotted propagules.

Results and Discussion

The present investigation was aimed at study of vegetative propagation and mass multiplication behaviour of six commercially important bamboo species of Assam namely *B. vulgaris* var. *vittata, B. balcooa , B. bambos , B. nutans, B. tulda,* and *D. hamiltonii*. The different species responded differently with regard to sprouting of shoot and root formation. The pattern as observed is shown in the Table 1. It is evident from Table 1 that sprouting from nodes started within 7 to 9 days and root development started after 30 to 51 days of placing of culm cuttings in beds.

The responses of different species have been different. The number of propagules produced from each node, the average

Table 1

Time taken in sprouting and root development from culm nodes in different species of bamboo.

Sl. No.	Species	Time taken after putting the culm pieces in beds (days)			Av. ht. of propagules (m) after 30 days
		Sprouting	Root formation	New propagules ready for separation	
1	*Bambusa vulgaris*	7	30	45	1.51
2	*Bambusa bambos*	8	36	50	1.25
3	*Bambusa balcooa*	7	34	50	1.51
4	*Bambusa nutans*	8	40	60	1.32
5	*Bambusa tulda*	9	51	60	1.05
6	*Dendrocalamus hamiltonii*	8	48	60	1.25

diameters of the propagules produced etc., were recorded for each species and are reflected in tabular form (Table 2). It is observed that sprouting commenced after 7 days of planting in *B. vulgaris* and *B. balcooa* and within 9 days all six species were sprouted with the formation of 4 -5 sprouts in the initial stage. The propagules grew vigorously to reach an average height of 1.51 m in *B. balcooa* and *B. vulgaris*; 1.32m in *B. nutans*; 1.25m in *D. hamiltonii* and *B. bambos* and 1.05 in *B. tulda* on 30th day of placing of culm pieces in beds. The tiller number increased gradually along with the passage of time and average number of sprout per node was recorded 4-10 in all the six different species of bamboo. First root formation was noticed after 30 days in *B. vulgaris*; 34 days in *B. balcooa*; 36 days in B. *bamboo*; 40 days in *B. nutans*; 48 days in *D. hamiltonii* and 51 days in *B. tulda.* The rooting from the nodes took place in all the six species in the time period range of 30-51 days from the date of placing of culm cuttings in the beds.

As regards percentage of nodes producing propagules and the percentage of dead nodes the results show that highest percentage of nodes actively producing propagules had been in case of *B.vulgaris* (100%) followed by *B. balcooa* and *B. bambos* (90%); *D. hamiltonii* (85%); *B. tulda* and *B. nutans* (80%). Thus it may be concluded that the species too has some influence on growth and sprouting behaviour of nodes. The propagule formation in respect of different species of bamboo varies in different months (time intervals) and the average number of propagules produced by each node increases gradually. The maximum no. of propogules emerged in the period January to March (3.90 in *B. bamboos*; 3.84 in *B. balcooa*; 3.56 in *B. vulgaris*; 3.48 in *B. nutans*; 3.38 in *D. hamiltonii* and 2.92 in *B. tulda*. During the period January to March, Assam experiences rise in temperature (mean maximum temperature rising from 24°C to 29°C and mean minimum temperature rising from 10°C to 18°C), longer photoperiod, scanty to moderate rainfall. The cumulative effect of rising temperature longer photoperiod and rainfall creates a very favourable condition for the growth of bamboo rhizomes, rooting of rhizomes and sprouting of propagules from the bamboo rhizomes. The good response was exhibited by *B. balcooa, B. bambos, B. vulgaris* and *D. hamiltonii* where within 48 days of planting the root was developed and from 100 nodes more than 200 numbers of propagules fit for separation were produced whereas only 169 and 70 number of propagules were obtained from 100 nodes in respect of *B. nutans* and *B. tulda* even after 60 days of planting. This is in agreement to the finding of Banik (1985) who reported poor response of *B. tulda.*

The data recorded on the production of propagules has also been presented in Table 2. The *B. vulgaris* have been found to perform better than the other species of bamboo with regard to production of propagules during the period April 2004 - March 2005. On an average 180 numbers of propagules were produced by one node of *B. vulgaris* after 4 multiplications. While 165, 160, 159, 149 and 60 numbers of propagules were obtained in respect of *B. bambos, B. balcooa, D. hamiltonii, B. nutans* and *B. tulda* respectively within one year i.e. April to March after 4 multiplications. Kumar and Pal (1994) reported production of 25 propagules from one mother sapling of seed origin after two multiplications in a year in case of *B. tulda*. In similar studies on

Table 2

Statement of number of propagules produced at various stage of macro-proliferation for six bamboo species tried at Basistha Silviculture Centre, Guwahati during 2004-05, starting from 50 nos. of two-noded culm cuttings (100 nodes)

(* Nodes; ** Date of separation from culm nodes in beds; *** Actual number)

Bamboo species-wise details on macro-proliferation	No. of propagules produced from culm cuttings in beds (50 x 2 = 100 nodes)	Results of Macro-proliferation			
		1st stage	2nd stage	3rd stage	4th stage
1	2	3	4	5	6
I. *Bambusa vulgaris*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100*	50	50	50	50
(b) Date of separation	25/06/04**	28/08/04	20/10/04	20/12/04	28/03/05
(c) No. of polypotted propagules macro-proliferated	100*	45	46	46	44
(d) No. of polypotted propagules not proliferated but survived at this stage.	-	4	2	3	2
(e) No. of propagules died	-	1	2	1	4
(f) No. of propagules obtained from polypotted propagules started with	-	92	147	147	178
(g) Av. no. of propagules produced per cutting at this stage (f /a).	-	1.84	2.94	2.94	3.56
(h) Projected no. of survived propagules which would have been produced so far at the stage of macroproliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	370	1452	4842	17736
(i) No. of survived new propagules separated out of culm nodes proliferating in beds.	201	124	195	140	275

Contd...

1	2	3	4	5	6
(j) Projected total no. of propagules produced at the stage of macroproliferation out of 100 nodes (h + i).	201 ***	494	1647	4982	18011
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	2.01	4.94	16.47	49.82	180.11
II. *Bambusa bambos*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100 *	50	50	50	50
(b) Date of separation	24/06/04 **	26/08/04	22/10/04	25/12/04	26/03/05
(c) No. of polypotted propagules macroproliferated	90 *	44	44	43	48
(d) No. of polypotted propagules not proliferated but survived at this stage	-	4	5	6	0
(e) No. of propagules died	-	2	1	1	2
(f) No. of propagules obtained from polypotted propagules started with	-	94	110	142	195
(g) Average no. of propagules produced per cutting at this stage (f /a).	-	1.88	2.20	2.84	3.90
(h) Projected no. of survived propagules which would have been produced so far at the stage of macro-proliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	404	1210	4002	16185
(i) No. of survived new propagules separated out of culm nodes proliferating in beds.	215	146	199	148	263
(j) Projected total no. of propagules produced at the stage of macroproliferation out of 100 nodes (h + i).	215 ***	550	1409	4150	16448

Contd...

1	2	3	4	5	6
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	2.15	5.50	14.09	41.50	164.48
III. *Bambusa balcooa*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100 *	50	50	50	50
(b) Date of separation	26/06/04 **	26/08/04	21/10/04	26/12/04	26/03/05
(c) No. of polypotted propagules macro-proliferated	90*	46	43	43	47
(d) No. of polypotted propagules not proliferated but survived at this stage.	-	1	2	4	3
(e) No. of propagules died	-	3	5	3	-
(f) No. of propagules obtained from polypotted propagules started with.	-	73	124	146	192
(g) Average no. of propagules produced per cutting at this stage (f /a).	-	1.46	2.48	2.92	3.84
(h) Projected no. of survived propagules which would have been produced so far at the stage of macro-proliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	315	1161	3971	15744
(i) No. of survived new propagules separated out of culm nodes proliferating in beds.	216	153	199	129	268
(j) Projected total no. of propagules produced at the stage of macro-proliferation out of 100 nodes (h + i).	216***	468	1360	4100	16012
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	2.16	4.68	13.60	41.00	160.12

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1	2	3	4	5	6
IV. *Bambusa nutans*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100 *	50	50	50	50
(b) Date of separation	27/06/04 **	26/08/04	23/10/04	27/12/04	31/03/05
(c) No. of polypotted propagules macro-proliferated	80 *	44	43	43	49
(d) No. of polypotted propagules not proliferated but survived at this stage.	-	03	03	05	01
(e) No. of propagules died	-	03	04	02	00
(f) No. of propagules obtained from polypotted propagules started with.	-	100	130	146	174
(g) Average no. of propagules produced per cutting at this stage (f /a).	-	2.00	2.60	2.92	3.48
(h) Projected no. of survived propagules which would have been produced so far at the stage of macro-proliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	338	1199	4088	14616
(i) No. of survived new propagules separated out of culm nodes proliferating in beds.	169	123	201	112	296
(j) Projected total no. of propagules produced at the stage of macro-proliferation out of 100 nodes (h + i).	169***	461	1400	4200	14912
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	1.69	4.61	14.00	42.00	149.12
V. *Bambusa tulda*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100 *	50	50	50	50

Contd...

1	2	3	4	5	6
(b) Date of separation	29/06/04 **	27/08/04	24/10/04	29/12/04	29/03/05
(c) No. of polypotted propagules macro-proliferated	80*	14	44	45	46
(d) No. of polypotted propagules not proliferated but survived at this stage	-	01	00	00	04
(e) No. of propagules died	-	35	06	05	00
(f) No. of propagules obtained from polypotted propagules started with	-	29	113	171	146
(g) Average no. of propagules produced per cutting at this stage (f /a)	-	0.58	2.26	3.42	2.92
(h) Projected no. of survived propagules which would have been produced so far at the stage of macro-proliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	41	339	1850	5709
(i) No. of survived new propagules separated out of culm nodes proliferating in beds	70	109	202	105	256
(j) Projected total no. of propagules produced at the stage of macro-proliferation out of 100 nodes (h + i).	70***	150	541	1955	5965
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	0.70	1.50	5.41	19.55	59.65
VI. *Dendrocalamus hamiltonii*					
(a) Initial total no. of rooted propagules (cuttings) started with (in poly pots)	100 *	50	50	50	50
(b) Date of separation	28/06/04 **	29/08/04	27/10/04	30/12/04	26/03/05
(c) No. of polypotted propagules macro-proliferated	85*	46	40	36	49

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1	2	3	4	5	6
(d) No. of polypotted propagules not proliferated but survived at this stage	-	01	02	07	00
(e) No. of propagules died	-	03	08	07	01
(f) No. of propagules obtained from polypotted propagules started with	-	107	122	144	169
(g) Average no. of propagules produced per cutting at this stage (f /a)	-	2.14	2.44	2.88	3.38
(h) Projected no. of survived propagules which would have been produced so far at the stage of macro-proliferation out of all propagules (cuttings) of previous step. (g x j of previous column)	-	443	1369	4499	15599
(i) No. of survived new propagules separated out of culm nodes proliferating in beds.	207	118	193	116	261
(j) Projected total no. of propagules produced at the stage of macro-proliferation out of 100 nodes (h + i).	207	561	1562	4615	15860
(k) Projected average no. of propagules produced so far from each node (j ÷ 100).	2.07	5.61	15.62	46.15	158.60

D. hamiltonii (Kumar *et al.*, 1992) and *B. bamboos* (Kumar, 1992) reported production of 16 and 49 nos. of propagules respectively in a period of 12 months after two multiplications. The physiological state of the culm also plays a crucial role for subsequent shoot production. After one year of propagules formation from the node it grows into a rhizome of about 500-1000 gm and continues to produce propagules.

From the results it is found that culm cutting with macro-proliferation technique is suitable for production of propagules in respect of all six species of bamboo and survival rate of these propagules at all the stages in more than 90%. This low cost method can be used as best vegetative method. It has been reported that macro-proliferation technique is an improvised vegetative propagation technique for self-incompatible species of bamboo through the use of both offsets and branch cutting (Koshy and Gopakumar, 2005). They have found out that the 114 saplings may be obtained from 5 offsets within a period of 20 months from *B. vulgaris*.

Results of the study show that through macro-proliferation a single node *of Bambusa vulgaris* var. *vittata, B. bambos, B. balcooa, Dendrocalamus hamiltonii, B. nutans* and *B. tulda* can be develop 180, 165, 160, 159, 149 and 60 number of propagules respectively within one year period, which could be increased gradually by continuing macro-proliferation further.

Bamboo seedlings possess inherent proliferating capacity and hence can be utilized for vegetative multiplication. Two-noded culm cutting technique with macro-proliferation involves regular separation of the shoot at two months interval in such a way that each shoot contains a portion of rhizome and few roots. This technique is suitable for production of propagules of *B. vulgaris* var. *vittata, B. bambos, B. balcooa, B. nutans, B. tulda* and *D. hamiltonii*.

SUMMARY

A new, easy and low cost technique has been developed for production of quality planting stock *of B. vulgaris* var. *vittata, B. balcooa, B. bambos, B. nutans, B. tulda* and *D. hamiltanii* vegetatively through two noded culm cutting with macro-proliferation which yields planting stock with survival rate of 90-100 %. Through this simple technique from a single bamboo node 60 to 180 nos. of bamboo saplings (propagules) can be produced in a year (April to March) depending upon the species selected. The best part of the technique is that it can produce bamboo planting stock round the year without involving many technicalities.

Key words **: Bamboo planting stock, *Bambusa vulgaris* var. *vittata, B. balcooa, B. bambos, B. nutans, B. tulda, Dendrocalamus hamiltonii,* Macro-proliferation, Low cost techniques, Assam.**

असम की कुछ चुनी हुई बांस जातियों के बृहत्प्रवर्धन का अन्वेषण

आर०एम० दुबे, पी०एस० दास व रीता चौधरी

सारांश

बैम्बूसा वल्गैरिस विभेद *विट्टाटा, बै० बेल्कुआ, बै० बैम्बोस, बै० न्यूटंस, बै० तुल्डा* और *डण्ड्रोकैलेमस हैमिल्टोनाई* का दो गाँठ वाली सन्धिस्तम्भ कलमों से वर्धीप्रवर्धन कराने की उत्तमकोटि रोपणसामग्री तैयारी करने की नई, सरल और अल्पमोली विधि विकसित की गई है जिनसे 90–100% अतिजीविता देने वाली रोपणसामग्री

बृहत्प्रवर्धित की जा सकती है। इस सरल विधि द्वारा अकेली बांस गांठ से ही 60 से 180 तक बांस पौधे (प्रवर्ध्य भाग) एक वर्ष (अप्रैल से मार्च तक) तैयार किए जा सकते हैं जिनकी संख्या चुनी गई बांस जाति पर निर्भर है। इस विधि की सबसे अच्छी बात यह है कि इसके द्वारा बांस की रोपण सामग्री पूरे वर्ष भर तैयार कराई जा सकती है और ऐसा करने में बहुत ज्यादा तकनीकें भी उपयोग नहीं करनी पड़ती।

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