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Research Article

EFFECT OF PLANT GROWTH REGULATORS ON ROOTING BEHAVIOR *INDENDROCALAMUS STRICTUS* (ROXB.) NEEDS THROUGH BRANCH CUTTINGS

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Abstract: Bamboo, a fast growing woody grass, exhibits multidimensional significance for humankind. Among various species, *Dendrocalamus strictus* covers around 45% of total bamboo resource of the country. To meet the public and industrial demand, large scale propagation becomes crucial but due to irregular flowering cycle and monocarpic nature, seed based propagation is limited. Due to abundant availability and easy handling practices, a branch cutting based macropropagation experiment was performed in the mist chamber of Forest Research Institute, Dehradun. Experiment was designed in completely randomized design. Three various plant growth regulators *viz*. IAA, IBA and NAA were used with concentration 2000 and 4000ppm. Result showed that IBA_2000 treatment was best for the branch cuttings of *D. strictus* where maximum root length and root number was found to be 25 cm and 20 respectively. There is significant difference in the root length and root numbers of various treatments. Overall rooting percentage was 25.40% with maximum percentage of 66.66% in IBA_2000ppm treatment. This method is effective for the mass propagation of *D. strictus*.

Keywords: *Dendrocalamus strictus, Monocarpic, Macropropagation, IAA, IBA and NAA*

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Introduction

Bamboos, which are important group of arborescent grasses, play a crucial socio-economic role for the country. Often referred to as green gold, bamboos are sufficiently cheap and plentiful to meet the vast need of our society and industries. These are useful from cradle to coffin so also called as "poor man's timber". These are commonly used for various purposes such as buildings, scaffoldings, composites interiors, bridges, bio-energy and fabric [1]. Due to increasing environmental and forestry challenges and to meet the indigenous demand, bamboos are extracted and exploited mainly from the natural forests thus their rich resources are depleting gradually. Bamboos is monocarpic i.e. flowering once in life and death after flowering so the availability of seeds is always limited. In present scenario, plantations outside the forest are the better alternatives to fulfil the increasing demand of bamboo and bamboo based products. Due to limited availability, low viability and poor seed storage characteristics, propagation through vegetative means is very crucial in bamboo.

In India bamboo growing area is about 15.6 million hectare out of which 45% is comprised by *Dendrocalamus strictus* [2, 3]. *D. strictus*, a densely tufted bamboo, is a predominant and widely distributed species across India. It is mainly found in semi-dry and dry zones along plains, watersheds and hilly tracts to an elevation upto 1000 m thus it has a capacity to grow in the wide matrix of various agro-climatic conditions. Due to its tufted sympodial clumping structure, it is s suitable species for the afforestation in difficult sites, forest landscape restoration and control over soil erosion. Flowering cycle of *D. strictus* varied from 25-45 years [4] so propagation of this bamboo is mainly done by vegetative means. Divided into nodes and internodes through its culm, each node of *D. strictus* has axillary bud which consists of root and shoots initial cells. Rooting in bamboo is affected by various factors like rooting media, types of planting material, season, type and concentration of growth hormones [5]. Macropropagation through cutting is done by two types of cuttings viz. culm and branch cuttings. Culm and branch-based propagation is suitable because of easy handling and abundant availability [6, 7].

Propagation through branch cuttings is easier than culm cuttingsbecause of less destruction to the clump, abundant availability and easy handling [8]. Season or period of collection of cuttings shows direct influence on the rooting [9-11]. Interaction between species and season is the most critical and summer is the most suitable season for the majority of the species [12]. Banik (1984) performed macropropagation in long pre- rooted cuttings of about 0.5-1.0m and achieved some good results. Gulabrao *et al*. (2012) performed culm cuttings-based experiment which were collected in summer and obtained maximum 70% sprouting and 53.33% rooting. The study on the propagation in *D. strictus* through branch cuttings has been performed by Agnihotri and Ansari (2000) but achieved lesser rooting percentage. Due to changing climatic conditions and increasing demand, an improved and farmer friendly macropropagation protocol is needed to enhance the bamboo productivity. To achieve a better and standardized method for the rooting in *D. strictus* through branch cuttings, this experiment was performed.

Materials and methods

To estimate the effect of rooting hormones on the rooting incidence from the branch cuttings of *Dendrocalamus strictus*, experiment was conducted in the mist chamber of Forest Research Institute, Dehradun. The experiment was laid down in completely randomized design (CRD) with six treatments with three replications and one control. The branch cuttings with double nodes were collected from the germplasm bank of *D. strictus* in the month of June, 2016. Cutting length ranged 20.25cm to 30.4cm with an average of 25.31 (SE=± 0.59) cm. The diameter of branch cutting ranged 0.80 cm to 1.70 cm with an average of 1.19 (SE= ± 0.05) cm. Cut ends of juvenile cuttings are very much prone for fungal attack so collected branch cuttings were treated with systemic fungicide Carbendazim with concentration of 1g/L [13].Cuttings were treated with six different concentrations of rooting hormones Indole Acetic Acid, Indole Butyric Acid and Naphthalene Acetic Acid. Each hormone was taken in 2 different concentrations *viz*. 2000ppm and

4000ppm and prepared with neutral talcum powder. The distal cut ends of cuttings are the entry sites of pathogens causing several diseases so these were covered by parafilm to avoid further infections [Fig-1]. The proximal end of cut near the 1st node and hormone mixture was applied to this end. Then those cuttings were planted in the poly bags in potting media with mixture of soil, sand and FYM in 2:1:1 ratio [Fig-1].

Fig-1 Planting of branch cuttings of *D. strictus* in the mist chamber

In the mist chamber conditions, temperature of 37-40°C and 85-90% humidity was set which was further maintained automatically. The data of temperature and humidity inside the mist chamber were recorded during experiment and mean and standard deviation of whole month were calculated [Table-1]. These cuttings were uprooted from the poly bags after four months of planting and the observations were recorded. The data for rooting incidence, root length and root number were recorded after uprooting the cuttings in the month of October [Fig-2]. These data were analyzed using software Statistical Package for the Social Sciences (SPSS).

Table-1 *Temperature and Humidity maintained in the mist chamber*

SN	Month	Temperature (Mean±SD)	Humidity (Mean ±SD)
1	June	(39.13±0.60)ºC	(86.80±1.24)%
2	July	(38.95±0.64)ºC	(87.32±1.36)%
3	August	(38.52±0.78)ºC	(87.82±1.37)%
4	September	(38.21±0.70)ºC	(87.26±1.39)%

Fig-2 Difference in Rooting in the branch cuttings of *D. strictus* in the mist chamber Rooting by (a) NAA_2000ppm; (b) IAA_4000ppm (c) IBA_2000ppm

Table-2 *Pair-wise analysis of the treatments for Root length*

Sample combinations	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
control- IBA_2000	21.389	6.608	3.237	0.001	0.025
NAA_4000-IBA_ 2000	21.056	6.608	3.186	0.001	0.030
IAA_2000-IBA_2000	-20.833	6.608	-3.153	0.002	0.034
IAA_4000-IBA_2000	-20.667	6.608	-3.128	0.002	0.037

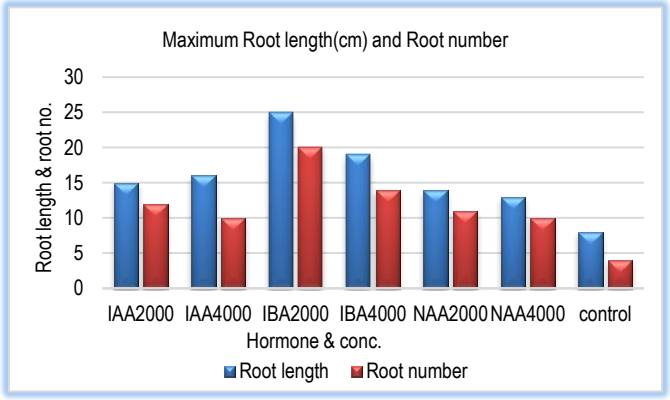

Fig-3 Comparison of maximum root length and root number in various treatments

Table-3 *Pair-wise analysis of the treatments for Root Number*

Sample combinations	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
control- IBA_2000	21.667	6.608	3.279	0.001	0.022
NAA_4000-IBA_ 2000	21.5	6.608	3.254	0.001	0.024
IAA_2000-IBA_2000	-21.222	6.608	-3.212	0.001	0.028
IAA_4000-IBA_2000	-20.889	6.608	-3.161	0.002	0.033

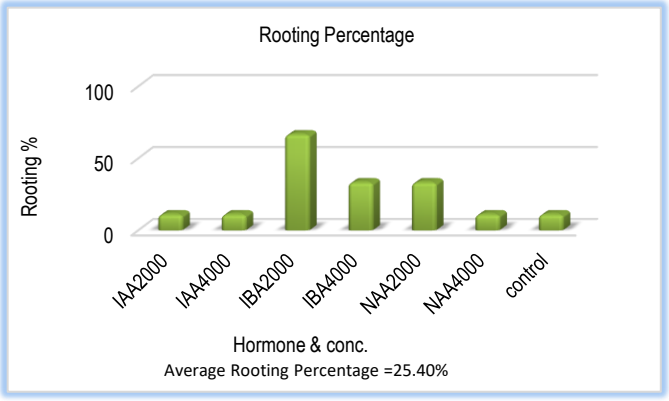

Fig-4 Comparison of rooting and sprouting percentage in various treatments

Table-4 *Kruskal - Wallis test summary*

S	Parameter	Sig.	Result
1	Rooting	0.054	Significant across the categories of treatment at 10% significance level (p<0.10)
2	Root Length	0.011	significant across the categories of treatment (p<0.05)
3	Root Number	0.009	significant across the categories of treatment (p<0.05)

Discussion

Various plant growth regulators like auxins stimulate and promote rooting in stem cuttings but the effectiveness of the auxins varies with season, concentration, chemical nature and mode of treatment of the auxin [14,15].The results show that the best combination for the rooting in the branch cutting of *D. strictus* is Indole Butyric Acid at 2000ppm concentration and varying root length and number reveals that rooting is significantly affected by rooting hormones under mist chamber conditions [Fig-2,3,4]. Pair wise summary shows that there is significant difference in the root length and root numbers of control and IBA_2000, NAA_4000-IBA_2000, IAA_2000–IBA_2000 and IAA_4000-IBA_2000 [Table-2&3]. Maximum root length and root number was found to be 25 cm and 20 nos. in IBA_2000 treatment respectively [Fig-3]. Rooting percentage was analyzed and it was found that maximum rooting percentage was found in IBA 2000 which was 66.66% and overall rooting percentage was 25.40% [Fig-4]. Kruskal-Wallis test was performed as the dependent variables were not normally distributed as seen by significant value of Shapiro-Wilk test also. Kruskal –Wallis test results revealed that rooting, root length (RL) and root number (RN) were significantly distributed across the various treatments [Table-4]. Rooting in *Dendrocalamus strictus* was found to be very difficult as performed in numerous standardization experiments. Difficult rooting may be because genus *Dendrocalamus* consists of more lignocelluloses than other genus of bamboo. Due to presence of lignification's in internal culm tissue (sclerenchyma tissues) forming a continuous layer that surrounds primary phloem and the vascular bundles and subsequently results lesser percentage of rooting [16]. Propagation through branch cutting is easier because of abundant availability of material and non-destructive approach to the mother clump. Branch cutting method is also useful because macropropagation is also farmer friendly. In *D. strictus*, less work has been carried out in cutting based macropropagation. Macropropagation through branch cuttings was performed in *Bambusa vulgaris var.* striata and *D. strictus* to analyze the seasonal variation. Average annual rooting (6.90%) with maximum rooting (30.3%) in February was obtained in *D. strictus* [17]. Although difficult rooting is the bottle neck in *D. strictus* but due to its various uses in paper-pulp industry, construction and edible purposes the value of this bamboo becomes more crucial.

Of the total bamboo growing area in India, *D. strictus* occupies largest resource so its improvement and propagation is the necessity of present time. In 2017, Government of India amended Indian Forest Act and exempted bamboo from the definition of 'Tree', now bamboo can be cultivated and harvested in private/community land without the permit and transit of forest department, so this protocol of macropropagation through branch cuttings in bamboo with better rooting percentage through branch cuttings is crucial for productivity enhancement through macropropagation.

Conclusion

Dendrocalamus strictus occupies a significant position among various bamboo species in India due to its wide distribution & adaptability, numerous uses and easy silvicultural practices. Its products have many opportunities and perspectives for supporting livelihoods of rural and tribal people. A good, recent and handy propagation protocol will be useful to fill the gap between demand and supply of bamboo and in this prospect *D. strictus* is crucial for the sustainability of the utilization of bamboobased products.

Application of research: Vegetative propagation of economically important and difficult to root bamboo species *Dendrocalamus strictus* through the branch cutting was performed successfully with the better rooting percentage than previous studies and the study is crucial for mass multiplication of *D.strictus.*

Research Category: Vegetative Propagation

Abbreviations: IAA- Indole Acetic Acid, IBA- Indole Butyric Acid,
NAA- Naphthalene Acetic Acid

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Study area / Sample Collection: Germplasm Bank of *Dendrocalamus strictus*, Forest Research Institute, Dehradun

Cultivar / Variety / Breed name: *Indendrocalamus strictus* (Roxb.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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