Annual Growth Periodicity of Culm and Rhizome in Adult Clumps of *Melocanna baccifera* (Roxb.) Kurz (Bambusoideae : Gramineae)

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Abstract

The growth periodicity of clum and rhizome in *Melocanna baccifera* clumps were studied. The culm emergence is maximum in July to mid-September. It was observed that everyday only the middle internode of a developing culm elongated maximum and moved gradually in successive order from the base to the tip of the culm. The lower internodes rarely elongated. The movement and elongation of rhizome neck in the clump seemed to take place either slowly or actively throughout the year irrespective of seasonal variation. The culm emergence and rhizome neck development took place simultaneously. The growth periodicity of underground rhizome system and culm on the ground was found to be interrelated and seemed to be alternating with each other. Periodicity for culm emergence and rhizome neck development in *M. baccifera* was influenced by both soil and air temperature and ambient moisture condition.

সারসংক্ষেপ

মুলিবাঁশের ঝাড়ে কাণ্ড ও ভূনিম্নস্থ রাইজমের বৃদ্ধিকাল পর্যবেক্ষণ করা হয়। জুলাই থেকে সেপ্টেম্বর মাসের মাঝামাঝি সময় পর্যন্ত নতুন কোড়ল বেশি গজায়। একটি সদ্যজাত বর্ধনশীল কোড়লের মধ্যভাগের পর্বসন্ধিই দৈর্ঘ্যে বাড়ে সবচেয়ে বেশি এবং এ নিয়মে ধীরে ধীরে তা আগার দিকে অগ্রসর হয়। নিচের পর্বগুলো কদাচিৎ লম্বায় বাড়ে। ঋতুর বিভিন্নতা সত্ত্বেও ভূনিম্নস্থ রাইজমের গলার বৃদ্ধি মোটামুটিভাবে সাড়া বছর ধরেই ধীরে ধীরে চলতে থাকে। লক্ষণীয় যে, ঝাড়ে নতুন কোড়ল গজানো এবং তাতে রাইজম-গলার দৈর্ঘের বর্ধন একই সাথে ঘটে থাকে। ভূনিম্নস্থ রাইজমের এবং ভূমির উপরে বাঁশের বৃদ্ধিকাল সম্পর্কযুক্ত এবং একে অন্যের বিপরীতে ঘটে থাকে। মুলি বাঁশের ঝাড়ে কোড়ল গজানোর সময়কাল এবং রাইজম বৃদ্ধিকাল ভূমির ও বায়ুর তাপমাত্রা এবং আর্দ্রতা দ্বারা প্রভাবিত হয় বলে প্রতীয়মান হয়।

Key words : Bamboo, bud break, culm elongation, culm emergence, growth periodicity, *Melocanna baccifera*, , rhizome neck elongation

Introduction

Melocanna baccifera is an important hilly bamboo species of estern part of south Asia. This bamboo is growing naturally both as pure and mixed vegetation throughout the hill forests of Bangladesh and Myanmar, and distributed from the northeast (Assam, Arunachal, Meghalaya) and eastern part (Tripura, Nagaland, Manipur, Mizoram) of India. Locally, in Bangladesh, the species is known as *muli* bamboo. The young (less than one year old) culms do not produce branches. They have drooping tips with few leaves and persistent straw colour culm sheaths on the nodes. Such culms with drooping tips are the common views of the *Melocanna* forests during October to April. The species has open and diffuse type of pachymorph rhizome system with long (1.0-2.0 m) rhizome necks which have the ability to spread and quickly cover the vacant space of the hills by producing culms, provided the plant is not heavily disturbed (Banik 1994). Therefore, the rhizomes of many different clumps of *M. baccifera* intermingle with each other forming an under-ground net-work and in the forest it is impossible to demarcate the boundary of a clump. This condition usually makes impossible for other plant species to invade the area. Such underground rhizome net-work helps protect soil erosion in the hills from monsoon rain (Banik 1989). It is not known in which month of the year such long necks are developed from the underground portion of a culm and by how much time a rhizome neck completes its elongation before producing a new culm above the ground. The time required for complete elongation of a culm and the initiation of branches from the nodes are also not known. This knowledge of growth periodicity is essential for developing a scientific management system for optimising the yield of *Melocanna* forests. Therefore a study was undertaken on the growth periodicity of this bamboo species and reported herein.

Materials and method

The study was conducted during 1984 to 1986 on the 10-12 years old five clumps of *Melocanna baccifera* at the Bambusetum of Bangladesh Forest Research Institute (BFRI), Chittagong. The climatic conditions of soil and air in Bambusetum were also recorded (Tables 1 and 2). The soil temperature at three different depths (50,100 and 200 cm) depths was measured everday at 7 am and then mean was calculated. Daily air temperature, relative humidity and amount of rainfall were measured and recorded.

The clumps were raised in 1973 by planting part-clumps (a group of 3 offsets jointed by rhizome necks) collected from forest.

The following observations were made daily :

Culm elongation : Just after the appearance of newly emerged culms at the soil level 15 of these culms were marked randomly by pencil from five clumps. The height of the elongating culms were recorded daily at 8 am by a digital measuring pole graduated in centimetre. Data recording was continued till the culms completed their elongation.

Bud break and branching on the culms : The time and pattern of bud break, branching and leaf production in the randomly selected culms were recorded.

Rhizome neck production and elongation : Soils around the randomly selected 15 newly emerged (35-50 cm tall) culms were excavated carefully so that underground portion did not get any injury. Thus the underground rhizomes were exposed and observed if any daughter rhizome necks developed from these newly emerging culms. The length of the rhizome neck, if found developed, was measured. The soils along the rhizome necks were dug for observing the movement pattern of rhizome necks and measured the distance travelled by each neck without touching them. The measurements from a rhizome under study were recorded on Monday every week till the emergence of new daughter culm in the next year. After each observation, the rhizome necks were again covered loosely with soil.

Result and discussion

Period of culm emergence and rhizome neck development : A clump of *M. baccifera* may start producing culms any time between May to mid-November (Table 1). The culm emergence is maximum in July to mid-September similar to those of other bamboo species growing in Bangladesh (Banik 1993). Both the soil and air temperature during the months of culm emergence were about 28.0°C and 26.0°C respectively. The mean relative humidity was about 65%. The monthly mean total rainfall during these months was within 100-800 mm (Table 1).

During the month of November to April the culm emergence is usually stopped in a clump. The non-emerging period was comparatively dry during which the soil and air temperatures were low as compared to the period from July to November when culm emergence takes place.

Thus, it appears that periodicity for culm emergence in *M. baccifera* is influenced by both soil and air temperature and moisture condition of the climate. The culm emergence period for *M. baccifera* is about 7 months in a year (Table 1).

Soon after emergence, culms elongate very slowly up to 1.0-2.0 m within 20 days and then gradually gain speed until they attain the optimum size and thereafter the rate of elongation gets slowed down quickly. Initially, data on the length of a culm was recorded everyday at 8 am in morning and at 5 pm afternoon. The record in the afternoon showed that culm did not elongate between 8 am and 5 pm, but it appeared from the record taken in the next morning that culm elongated. This suggests that culm elongation mostly takes place in the night, and accordingly later on data were recorded only in the morning. From the daily measurement of length of all the internodes of an elongating culm, it was further observed that everyday only the middle internode elongated maximum and moved gradually in successive order from the base to the tip.

Table 1. Periodicity of clum emergence in *Melocanna baccifera* in relation to soil and climatic conditions at the Bambusetum of Bangladesh Forest Research Institute, Chittagong.

Site factors and culm emergence	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Soil temp°C (Avg.)	22.3	23.0	25.5	28.1	29.0	28.8	28.7	28.7	28.7	28.9	26.7	23.5
50 cm depth	20.8	22.4	26.5	29.2	29.7	29.3	29.0	29.0	29.1	29.6	25.9	21.7
100 cm depth	22.1	22.8	25.3	28.3	29.1	28.9	28.7	28.6	28.5	28.5	26.5	23.5
200 cm depth	24.2	23.8	24.9	26.9	28.2	28.3	28.5	28.6	28.6	28.7	27.7	25.3
Air temp°C	18.5	20.9	25.3	26.6	26.9	26.6	26.0	26.5	25.3	25.5	20.9	16.2
Rel. humidity (%)	56.5	55.5	55.3	62.2	65.1	67.4	70.8	67.2	66.0	66.0	63.1	55.9
Total rainfall (mm)	17.9	12.7	33.6	117.5	375.6	566.3	783.0	426.1	321.6	247.1	95.1	13.6
Culm emerged	0	0	0	0	0.1	0.7	1.7	3.7	2.1	0.9	0.2	0
(No./clump) ± SE					± .07	± .2	± .5	± .7	± .6	± .3	± .08	

The lower internodes to the mid one rarely elongated. Say on June 10, a culm having 11 visible internodes was 150 cm tall. The mid length of the culm was 75.0 cm and the internode number 5 was in middle position. In the next morning (June 11) the culm became 178 cm tall and measurement of all the internodes showed that only the internode number 6 (middle internode) showed maximum (28.0 cm) elongation and below this the internode number 1 to 5 did not increase in length. Let us take an incidence of a culm elongation. On June 12, the immediate upper internode number 7 elongated maximum, on the following days the upper mid-internodes, thus, increased in length sequentially for complete elongation of the culm. Internodal elongation begins at the basal portion of the nodes. The maximum rate of culm elongation in *M. baccifera* was found to be 44.0 cm per day and the minimum 15.0 cm. Such speedy rate was observed during second half of the complete culm elongation period. Total culm elongation period was 55-60 days. Similarly Osmaston (1918) reported that the daily extension growth in culms of *Dendrocalamus giganteus* was 10 to 30 cm with a maximum of 58 cm. Culms did not show any diameter increment during or after the elongation period. That is, the diameter with which culm emerge remains unchanged throghout its life. Thus, it seems that the size of the diameter of a culm is determined by the size and vigour of the bud present in the mother rhizome from where it originates.

Culms emerged in a clump of *M. baccifera* any time during the month of May to November. The rhizome neck (s) were also developed geotropically simultaneously below the ground from the rhizomes of emerging clums (Table 2). At the same time culm completed its elongation reaching a maximum height within 55-60 days (mid-May to mid-July) while rhiozme neck more or less slowed down its elongation. While excavating the soil around horizontally elongating rhizome neck to measure its daily movement if any portion specially tip is touched it stopped movement in the subsequent days. Therefore care was taken during excavating soil around the rhizome necks for measuring the movement. Within next 20-25 days (end of July to mid-August) culm sheaths at the apical nodes partially dislodged and culm started producing leaves directly at these 4-6 apical nodes. In the next 90-95 days (mid-August to November) no further growth (such as, bud break, branch and leaf production) were observed in the culm while underground rhizome neck was elongating steadily in horizontal manner. The climatic condition after August up to next February was gradually becoming dry and cold (Table 2). A young elongating culm does not have leaves and branches, all of its nodes are covered with culm-sheaths. In the subsequent winter and dry season (last part of November to mid-March) all buds on the culm nodes remain dormant and were somewhat completely covered with persistent culm-sheaths and did not produce any branches, but rhizome neck did not stop its horizontal elongation below the ground. Thus it appears that during cold and dry season all growth potentials were diverted towards the underground rhizome neck elongation. However, at the end of March buds break started besipetally in the culm nodes.

Bud activation, branches and leaves and rhizome neck development : Rhizome necks simultaneously showed rapid elongation during the next 55-60 days (March to May) as with the rising temperature and moisture content in surrounding soil and atmosphere. Culm-sheaths started dislodging besipetally, and bud break was in progress up to one-third of the culm. Simultaneously many thin branches were also produced in assembly from each bud. Leaves started developing within 2-4 weeks from the developing branches. Sheaths persist further dislodged, bud break and branching continued up to two-third portion of the culm. Most of the time culm-sheath persisted and nodal buds remain dormant on lower one-third portion (basal 3-7 nodes) of culm.

It appears that the movement and elongation of rhizome neck in *M. baccifera* was going on

Table 2. Culm and rhizome growth periodicity in the adult clumps of *Melocanna baccifera* in relation to month and climatic condition.

Growth time (date)	Culm emergence and elongation	Branch/ leaves on culm	Neck elongation of daughter rhizomes from mother rhizome	Daughter culm	Climatic condition				
					Month	Soil temp°C (Avg. of 50,100, 200 cm depth)	Avg. air temp.°C	Relative humidity (%)	Total rainfall (mm)
May to November 1st week (any time)	Say, emerged in May elongated 15 ± 5 cm	Not produced	Elongated 5±2 cm (Geotropic)	Not produced	May	29.0	26.9	65.1	376
May 2nd week to July 2nd week. (55-60 days)	Elongation completed 12.5± 1.2 m	Not produced	Elongated slowly 12 ± 2 cm (Horizontal)	Not produced	May Jun Jul	29.0 28.8 28.7	26.9 26.6 26.8	65.1 67.4 70.8	376 566 783
End of July to August 2nd week (20-25 days)	No more elongation, culm sheaths at the few apical nodes partially dislodged	Tip nodes of culm produced leaves alternately, branch not produced	Elongated slowly 15 ± 2 cm (Horizontal)	Not produced	Jul Aug	28.7 28.7	26.0 26.5	70.8 67.2	783 426
August 2nd week to Nov. 3rd week (90-95 days)	No growth	No further growth	Elongated steadily 45 ± 5 cm (Horizontal)	Not produced	Aug Sept. Oct. Nov.	28.7 28.7 28.9 26.7	26.5 25.3 25.5 20.9	67.2 66.0 66.0 63.1	426 322 247 95
Nov. 3rd week to March 2nd week of next yr. (110-115 days)	No growth	Bud break started in culm nodes besipetally at end of March	Elongated slowly 55 ± 10 cm (Horizontal)	Not produced	Dec. Jan Feb Mar	23.5 22.3 23.0 25.5	16.9 18.5 20.9 25.3	55.9 56.5 55.5 55.3	14 18 13 34
March 3rd week to May 2nd week (55-65 days)	No growth	Bud break was in progress	Elongated rapidly 98 ± 10 cm (Horizontal)	Not produced	Mar Apr. May	25.5 28.1 29.0	25.3 26.6 26.9	55.3 62.2 65.1	34 118 376
May 2nd week to June 3rd week (40-45 days)	No growth	New branch and leaves developed	Tip of the rhizome neck bent upward, pierced above the ground	Daughter culm emerged	May Jun	29.0 28.8	26.9 26.6	65.1 67.4	376 566

either slowly or actively throughout the year irrespective of seasonal variation. However, the rhizome neck elongation was slow only when the aboveground mother culm exhibited growth and produced branches and leaves. But when (August to November and March to May) culm exhibited no or little growth (bud activation, branches and leaves development, etc.), rhizome neck elongation was normal to rapid. Thus it appears that in *M. baccifera* the annual growth periodicity of underground rhizome system and culm above the ground is interrelated and seems to be alternating with each other. New rhizome proper started developing from the tip buds of the mother rhizome necks any time during May to August and within 2-3 weeks bent upward (negative-geotropic) at right angle piercing the soil and appeared above the ground producing daughter culms.

In contrast to *M. baccifera* most of the tropical clump forming species of *Bambusa* and *Dendrocalamus* possess compact pachymorph rhizomes. In these genera development of daughter rhizome starts only after complete elongation of culm of at least 9-12 months of age. As they do not produce long rhizome necks and therefore no such large net - like structures are formed, and each clump covers only a small amount of land (Banik 1997).

Conclusion

The study revealed that in *M. baccifera* the movement and elongation of rhizome neck from a mother rhizome continued either slowly or actively throughout the year irrespective of seasonal variation. So any soil work in the *Melocanna* forest may interrupt the culm production. Once the hills are heavily deforested, it becomes difficult to create green cover, and in many cases, man-made plantations fail. The clump of *M. baccifera* with its long rhizome necks have the ability to invade and quickly cover the exposed deforested hilly areas and can form underground network, and thus can conserve the soil and water in catchment areas. Therefore, preference may be given for selecting *M. baccifera* in reforesting the denuded and degraded hills and also inside the well thinned plantations of long rotation timber species.

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