gregari ous flowering vis-a-vis age gradations of (bambusa arundinacea)

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Flowering of bamboo is generally known as a passing phase, but it has a far reaching effect upon plantations. Age gradation is an important factor in plantations, and with available resources, the Paper Industry should give more stress upon systematic plantations to tide over the awful situation of bamboo scarcity.

The importance of bamboo as versatile raw material for paper in India cannot be over-emphasized. To-day, over 70% of the total pulp produced in the country is from bamboo. Bamboos are common associates of our deciduous and moist deciduous forests, and they are found almost all over the country. Until recently, bamboo was looked upon as undesirable component of our forest but as the paper industry progressed and the demand for fibrous raw material increased, we have now started thinking in terms of reclaiming this vital raw material resources. With little or no attention paid for a long time in the past, the present yield from the natural growth of bamboo is very low (about 0.5 tons per acre per year). But by scientific approach to the management of bamboo forests aided by application of fertilizers and artificial means of regeneration, the yield can be enhanced by many times.

Out of over 130 varieties of bamboos growing in India, **Bambusa arundinacea** and **Dendrocalamus strictus** are commercially the most important. **Dendrocalamus strictus** has wider distribution as compared with **Bambusa arundinacea**, the later being mostly confined to moister localities having over 50″ of rainfall. But **Bambusa arundinacea** attains much larger dimensions as regards height and girth and yields about 4 to 5 times as much material per clump compared to **Dendracalamus strictus.** Cultivation of this bamboo is, therefore, bound to play an important role in bridging the widening gap between demand and supply of raw material being anticipated by the pulp industry. On account of moisture loving nature, its propagation may not be possible everywhere, but in the major parts of our moist deciduous forests, this bamboo could be aided by artificial means to extend its occurrence.

In its rate of growth, **Bambusa aruad'nancea** is one of the fastest known members of the plant kingdom. Agnes Arber chronicles, a number of measurements in terms of growth per day in various species of bamoos. This includes record of about a meter per day for **Bambusa arundinacea** which is the highest, although, about 30 cm. per day may be considered as an average rate of growth per day for this specie.

Bambusa arundinacea is a very ideally suited bamboo in plantation forestry, as ascertainable from the large scale plantations of this species raised by the West Coast Paper Mills Ltd., Dandeli. It is quick in establishment and has a very fast rate of growth reaching exploitable age within about 8-10 years of planting. Being a shade-tolerant specie, it is capable of co-existing as an under-storey with the tree crop in forests, thus obviating the difficulty of obtaining separate stretch of land for raising plantations. However, it may be stated that even raising of pure plantations of this specie would be very profitable, and in suitable climatic zones, it might be possible to get even upto 10 tons of air-dry material per acre per year. This yield is nearly double the expected average yield from **Eucalyptus** hybrid plantations being raised on large scales in India.

Silvicultural Characters: Bambusa arundinacea is a large, clump-forming bamboo attaining 25-30 meters height and 40-50 cms. girth, with thorny branches. Mature clump of this species throws out on an average 5 new shoots per year under natural conditions. The new shoots emerge with the onset of mansoon every year and they complete their height growth within three months. It needs fertile soil with reasonably good drainage and thrives best on moisture localities especially on nalla beds. It being shade tolerant, generally occupies second storey in moist deciduous forests, although for its optimum development over-head light is decidedly beneficial. It is fire hardy. It flowers gregariously once in 35 to 45 years.

Gregarious flowering:—Gregarious flowering is an interesting phenomenon and is a matter of direct concern to the pulp industry. After gregarious flowering, the bamboo clumps die en bloc and its natural regeneration takes place from the seeds falling on the ground from the flowered clumps. The regenerated

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seedlings take over 12-15 years under natural forest conditions and about 8-10 years under artificial conditions to attain maturity so as to be able to yield exploitable bamboos for pulping. Thus, during this period of 10-15 years, the pulp industry, solely depending upon bamboo as raw material, has to face unsurmountable difficulties in finding out raw material, to keep the wheels of the mills moving.

The term "gregarious flowering" in bamboo means simultaneously coming into flowers of a large compact tract of bamboo forest in the same year. This type of flowering advances year after year covering fresh adjoining tracts in a definite wave like fashion and takes nearly 5 to 6 years or sometimes more to cover an entire flowering district. Within the gregarious flowering is also recognised three distinct stages, namely :

(1) Preliminary sporadic flowering of a few clumps in a tract a year or so in advance of gregarious flowering ;

(2) Secondary gregarious flowering of almost all clumps engulfing the entire block of forest ; and

(3) final sporadic flowering of a few remaining clumps scattered all over the block.

Thus, even in a given tract, when flowering commences it takes atleast three years, often more, to complete all the three stages. For instance, in Dandeli Forest Division of North Kanara district, recent flowering of **Bambusa arundinacea** commenced in a sporadic fashion in 1958, which was followed by gregarious flowering from 1959 to 1961, and its final sporadic flowering is still going on and is still incomplete. Moreover, taking into account the entire district of North Kanara, there are considerable tracts of bamboo forests upto which the wave of gregarious flowering has not yet advanced and from general observations, it appears as if it it would take at least, about another 5-6 year to complete gregarious flowering in the entire district. It is difficult to explain as to why a few clumps should flower either in a preliminary or final sporadic fashion. Although this phenomenon needs to be further investigated, it is attributed at present to clumps originating from seeds of different origin. However, as gregarious flowering proper that covers over 90% of the bamboo crop in a tract is more of a concern to the industry, the sporadic flowering in **Bambusa arundinacea,** which victimizes a negligible number of clumps may be viewed as an exception rather than the rule. Thus, it is safe to assume that in North Kanara district gregarious flowering of **Bambusa arundinacea** takes more than ten years to cover the entire bamboo forest. This is confirmed from the past observations of flowerings recorded, which are given below :

Sl. No.	Year of flowering	Authority	Locality of flowering.
1.	1804	Bedaome	West Coast of India
2.	1864-66	Gamble	North Kanara
3.	1868	Beddome	West Coast of India
4.	1874-1884	Troup	North Kanara
5.	1882	Bourdillen	West Coast of India
6.	1900-1918	Troup	Kanara
7.	1911-1915	Troup	East Kanara
8.	1916-1923	F. A. B. Goelho	North Kanara
9.	1959-61	Author	North Kanara

It will be clear from the above record that from the dates of flowering it is not possible to calculate the life cycle of bamboo, as years of flowering recorded are far very extensive tracts, whereas in all these years flowering did not sweep simultaneously on the entire tract described but presumably only in some part of the area. Nevertheless, it will be appreciated here that the years mentioned do indicate that the gregarious flowering was spread over a long period covering more than ten years.

Bambusa arundinacea, like most other bamboos dies after flowering. Life cycle, the period between successive flowerings of this species, is estimated to be about 40 years in North Kanara. This estimate is supported by the past two successive observations on flowerings recorded precisely in the same tract given in the table (S. No. 8 and 9) above. It is difficult to explain as to why this life cycle varies between 35 to 45 years in other parts of India, as our knowledge on this aspect of study is very inadequate. It might be possible that this variation is genetically guided or has probably arisen due to improper recording of past dates of flowering of which the observations were not made successively in the same flowering tract, but were perhaps recorded at different parts of the entire flowering district.

Various reasons have been put forth as probable causes of inducing gregarious flowering, such as scarcity of water, abnormally high temperature, exposure to intense light etc., but the most vehement opposition to this concept is found in the conservations of flowerings recorded of off-sets, which inspite of being planted in widely distant localities with different climatic conditions, flowered simultaneously with the parent stock.

M.M.A. and C. Riv.eri mention that the off-sets from a parent plant of **Arundinaria Japonica** introduced from Japan in the Bois de Boulgne, at Sceaux, at Marsheilles and at Hamma in Algiers, in 1850 flowered almost simultaneously at all places in 1867-68. It was been also noted (author) that a young clump of **Dendrocalamus brandisii** raised from an off-set obtained from Coorg in 1960 in the nursery of the West Coast Paper Mills at Dandeli flowered in 1962-63 along with the gregarious flowering of this species at Coorg in the same year. Detailed studies undertaken in Japan to correlate the flowering age with the size of clump, thickness of culm, soil fertility and moisture, exposure to sun, climatic conditions and locality factors have failed to give conclusive results (Huberman, 1959). It is, therefore, safe to assume for all practical purposes that the flowering cycle of bamboo is determined inherently by age and the role played, if any, by locality and climatic factors is almost negligible.

Age Gradations in Bamboo Plantation :

By age gradation in bamboo plantation it is meant establishment of a series of bamboo crops belonging to different age staggering by one year. From the evidences already recorded, it is clear that age is the deciding factor in determining the time of gregarious flowering in bamboo. It can be assumed, therefore, when such age gradations are established in bamboo plantations, the flowering would also take place in a staggering manner differing by one year, as and when the growing stock in the series completes its span of life.

For all practical purposes, it is sufficient in the case of **Bambusa arundinacea** plantations to establish age gradations over a period of ten years, as it takes just about 8-10 years under artificial conditions to grow up from seeds and develop into clumps yielding utilizable bamboos. Thus, when the gregarious flowering commences and reaches the last plantation in the series, the plantation first in the series which will have flowered ten years earlier could be re-established. Establishment of such plantations would render bamboo as more dependable raw material for the pulp industry, and by raising such plantations over a number of equiproductive blocks, it would be possible to obtain yield on sustained basis by adopting suitable silvicultural system of management, irrespective of gregarious flowering. Even a small scale attempt at establishing such a series of plantations is bound to serve as the best supplementary reserves of bamboo at a time when the natural bamboo supply is adversely affected after gergarious flowering.

There are usually two methods by which age gradations in bamboo plantations could be achieved :

1. **From Local seed collections :**—This would be a very simple method, provided the fresh seed is available for collection over a period of 10 years or so. Such favourable situation does exist in some large flowering districts like North Kanara, where the flowering actually extends over a period of 10 to 20 years. It is, therefore, possible to collect seed from these flowering districts every year and for many years in succession. If the seed so collected is successively sown in nursery beds year after year and the resultant seedlings are planted out separately in the same order, a series of plantation belonging to different ages staggering by few years can be established.

2. **By seed storage :**—Although gregarious flowering in some districts spreads over a number of years, this may not be the case in all the districts where this bamboo occurs. In some localities, the gregarious flowering might be completed in a matter of two to three years. In these localities, it would be difficult to establish age gradations in the plantations to be raised, unless continuous supply of seed can be obtained from other parts of the country where the flowering might be in progress. As this is doubtful, the sure solution to this problem would be to store the seeds from the local collections over a number of years. But the bamboo seed, under ordinary conditions of storage loses its viability within about a year. Although there are many modern methods known to the science of preserving seed viability over a number of years, much less work has been done so far as bamboo seed storage is concerned.

The two most important factors affecting storage of any seed appear to be seed moisture content and temperature. Seed moisture content in storage can be regulated by storing the dry seed in hermetically sealed containers. It is learnt that this method is being tried for bamboo seed at the Forest Research Institute, Dehra Dun, and the results are awaited. In this connection, an experiment conducted at Puerto Rico (D. G. White-1947) is very interesting and significant, wherein the seed of **Bambusa arundinacea** was stored at room temperature in sealed jars containing calcium chloride and it was found that the potency of seed actually increased with the storage, which will be evident from the record of germination tests given below :—

Batch No.	No. of days in storage	Germination %	
		$GaCL_2$ treatment	Control
1.	148 days	78	76
2.	227 days	81	36

It would be worthwhile repeating this experiment under our local conditions and to conduct it over a longer time to determine the maximum period for which the bamboo seed could be stored with this treatment. Too much variation in temperature during storage, again, adversely affects viability. Storage of seed in cold rooms having regulated temperature range, is a tested method and has been successfully used in storing pine seeds in the U.S.A. By an experiment, it has been shown that the pine seed after 29 years of storage in a cold room (Temperature range 41° – 50°F) could give best germination, whereas the seeds in fruit cellars, where the temperature ranged from 32° to 68°F, gave poor results.

The method of cold storage is, therefore, likely to prove very effective in maintaining viability of bamboo seed also over a very long period of storage.

The loss of viability is also attributed to exhaustion of stored reserve materials in the seed through respiration. In seeds, containing oil, rancidity of the oil content also plays an important role in the determination of viability. Since respiration is so important in the storage of seed, it may be suggested that coating of seed with an antioxidant, like starch phosphate, which has proved effective in storage of some delicate vegetable seeds, might also improve storage possibilities of bamboo seed.

As the seed of **Bambusa arundinacea** is a small size, it is possible to store over 60,000 (about 750 gms.) seeds in a container of one litre capacity, and as such, seeds stored in comparatively a small volume of space would be sufficient to raise a large plantation. The above methods of seed storage are bound to prove successful in seed storage of bamboo, in which case, the ideal of raising a bamboo crop with a complete series of age gradations covering almost the entire life cycle of, say, 40 years or so, would be within reach. Such a series of plantations would be of immense use in establishing seed plots which would in course of time be a perennial source seed supply, enabling the planters of bamboo to plan their plantations at any desired time.

This article is based on one presumption that the physiological life cycle of bamboo begins from the date of germination of seed to the date of gregarious flowering, and that this cycle is more or less constant. There are good reasons to believe in this presumption, as it is analogous with the short cycle species like rice, sorghum etc. belonging to the same family as bamboo (**graminea**), the seeds, of which, despite the period in which they are sown complete the same life span before they commence flowering. Such behaviour is also exhibited by other species like **Strobulanthes** whose life cycle is also known to be constant. It is, therefore, reasonable to suppose that the life cycle of bamboo may also be constant.

The bamboo on account of its multifarious uses and incredibly fast rate of growth is attracting world wide attention. Although several broad leaved woods, agricultural residues and grasses are being tried for their suitability in paper making in India, it should be noted here that it is not with a view to supplant bamboo, but only to supplement it. The bamboo with no problems like debarking and depithing, and with long fibre, low chemical consumption and high yield is bound to be our all time best raw material for paper, inspite of the technological progress in putting to use short fibred cellulosic materials for the manufacture of pulp. Therefore, any attempt at improvement of bamboo crop is bound to be a step forward in the right direction.

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