Research Paper Biology

Germination and Adaptation of Phyllostachys Pubescens (Moso Bamboo) in Uttarakhand

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ABSTRACT

Bamboo plantations are gaining importance all over the world due to fast growth rate, adaptability, resilience, substantial biomass production, soil/ water conservation, bio-energy generation, carbon sequester and CO2 sinks. The objectives of the study were to find out seed germination, seedling development and ecological adaptation of *Phyllostachys pubescens* in the temperate zone of Uttarakhand. *P. pubescens* commonly called Moso bamboo, having leptomorph rhizome system. Greater germination percentage in mist chamber may be attributed to better environment inside the mist chamber but the emerged seedlings were delicate, which resulted high transplanting mortality due to climatic shock. Field growth showed that survival was excellent and total planted seedlings alive two year after plantation in the field. Seedlings attained 1.8± 5.3 m height with 16.5± 1.6 culms plant^{-1} after two year of planting. The species spreading over the area and planting spacing has been completely covered by the culms. This initial trial can be used as rhizome bank, to supply planting material without waiting for long gregarious flowering, so that greater economic and environmental benefits can be obtained.

KEYWORDS Temperate, leptomorph rhizome, germination, mortality

Introduction

Bamboos are monocarpic, wind pollinated, produce seeds at long interval. Bamboos have immense socio-economic, cultural, ecological value and enormous potential to meet the needs of people, industries and capacity to sequester more carbon due to fast growth rate hereby mitigating the impact of climate change to some extent. Thus, bamboo plantations are gaining importance all over the world due to fast growth rate, ease of adaptation, resilience, substantial biomass production, soil/ water conservation, bio-energy generation, carbon sequester and CO_2 sinks**.** Bamboos based on their rhizome system are categorized into two type viz. sympodial (pachymorph) and monopodial (leptomorph). Four sympodial type viz. *Bambusa arundinacea, Dendrocalamus strictus* (Osmaston 1926) *Bambusa nutans,* and *Dendrocalamus hamiltonii* naturally occur in Uttarakhand. Rhizomes of sympodial type are confined to 3-4 m radius while rhizomes of Monopodial bamboo spread in large area through horizontal running rhizome system and thus having greater chance to meet rising bamboo demand. Bamboo regeneration from seed remains largely unknown.

Phyllostachys pubescens Mazel ex. H.de Lahaie, Moso bamboo, monopodial bamboo, naturally found in China and has also been naturalized in the neighboring countries (Isagi et al. 2004a), where it grows between 1000-1700 m elevations asl (Lai and Hsiao 1997). It is use in construction, furniture, handicrafts, baskets, human food, paper, textiles and bio-remediation. *P. pubescens* had highest culm mean height, diameter, net photosynthetic rate and carbon sequestration (14.6 kg CO_2 year^{-1} culm^{-1}) compared to other two species of *Phyllostachys* and one species of *Bambusa* (Granti et al. 2008). Thus, the species have greatest potential for biomass production, photosynthesis and carbon sequestration this species can contribute a major role to net sink for CO_2. Its flowering/seeding period is 67 year (Isagi et al. (2004b). The species also have immense potential to re-vegetate the frazil Himalayan forest ecosystem. Considering its diversified economically and ecologically uses this species was tried in Uttarakhand. The basic principle behind introduction is to develop a certified rhizome bank for the species from seeds, so that steady supply of rhizomes/ culms can be available in future to meet the societal needs and uplift rural livelihood. The rhizome banks are high density, seed origin, even aged plantations raised to serve steady supply of planting material without waiting for long gregarious flowering, The objective of the present study is to study the germination and adaptation of *P. pubescens* for the development of rhizome bank so that its mass propagation and planting programs initiated.

Material and Method

Seed germination and growth study was conducted in the Tangsa Research Centre near Gopeshwar, is situated at 30^{0}24′66.7″ N and 079^{0}17′70.5″ E at an altitude 1400 m asl. The climate in the study area is influenced by Monsoon pattern. Mean monthly temperature ranged between 7.2 ^{0}C (January) and 22.9 ^{0}C (June). Average rainfall was 1459 mm, bulk of which fall in the rainy season.

Seed of *P. pubescens* were imported from China. Clean seeds in three replicates each of 100 from seed lot were sown in two conditions i.e. mist chamber and nursery bed in randomize block design in the month of September. Seed germination was monitored for twelve weeks when no further germination was counted for six consecutive days (Bhatt et al. 2007). Initial viability of seeds was determined through cutting test taking three replicates each of 50 seeds. Seeds containing complete embryo were categorized as sound and all other (infested, diseased, shriveled, undeveloped embryo etc.) as empty seeds (Bhatt and Ram 2007, Pandit et. al. 2002). Seeds in mist chamber were sown in the germination trays containing washed sterilized river sand as a media while in nursery beds seed sown in sandy loam textured soil. Seedlings were transplanted in the root trainers in March 2007 and after six months seedlings were further transplanted in the polybags of 14 ×23 cm^2 size. Potting mixture for both the root trainers and polybags was the compost and soil in 3:1 ratio. In the month of March 2008 both mist chamber and open nursery seedlings has been planted in the field for growth, survival and rhizome study. Plants were planted at 2×2 m^2 spacing in 45×45×45 cm^3 pits. Nursery growth parameters were recorded in three replicates each having 12 plants, while 5 replicates each of 5 plants was used for field growth study. The design in both was randomized block design. Data of survival, height growth, rhizome emergence frequency and time to emergence, and number of developing shoots were recorded at the nursery and in the filed. T-test was used for survival, height and culms number between mist chamber and open conditions

Result and discussion

The seeds are light brown in colour elongated in shapes 1.1± 0.4 cm long with an awn like projection of 0.5±0.2 cm long at its tip. Seed germination started 25 days after sowing in mist chamber and 30 days after in nursery bed and completed within 70 days after sowing in both the

conditions. 1000 seed weight was 18.3± 2.0 g with sound seed percentage 57.7± 1.5 %. Seed germination percentage was greater in the mist chamber compared to nursery. It was 35 % in the mist chamber and 28 % in nursery (Fig 1). This variation could be due to greater temperature and humidity inside the mist chamber. The temperature was maintained between 25-35 ^{0}C with humidity between 70-80 % inside mist chamber. Uchimura (1990) showed that the germination rates were 7 to 60 % in *P. pubescens* and suggested that this depend on culture conditions. Yoko (2005) found germination rates was 54.9 % in open in *P.* meyeri.

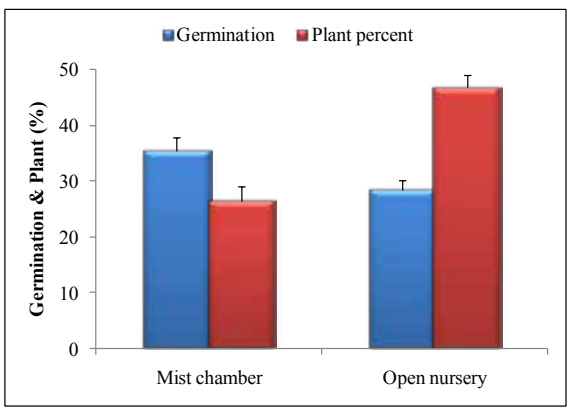


Figure 1. Seed germination (%) and plant percent of *P. pubescens* in mist chamber and open nursery conditions. Error bars indicated ± SE.

Transplanting mortality in the root trainers was very high and accounts 64 % and was observed in the first two months after transplanting. This may be due to transplanting shock, poor root/potting mixture contact, poor production of photosynthetic material by the young tiny seedlings. Field mortality in the mist chamber grown seedlings was also 18% high compared to open nursery. This is due to the fact that seedlings grown in the mist chamber were delicate and receives better growth in controlled conditions and when they were transplanted to open, high mortality occurs due to climatic shock. In contrast to this seedlings in the nursery conditions receives comparatively harsh environment and thus, transplanting mortality is less.

Nursery growth study reveals that one month after transplanting no further mortality was counted in the subsequent measurements in the open grown seedlings nursery whereas it stabilize two month after transplanting in mist chamber (Fig 2a). Seedling attains a height of 84.9± 4.3 cm in mist chamber and 77.1± 4.1cm open condition (Fig 2b). Number of culms was 2.5± 0.3 seedling^{-1} in mist chamber and 2.3± 0.2seedling^{-1} in open chamber conditions (Fig. 2c). The t test revealed that seedling survival (t=10.8, 11 df, p<0.01) was higher in open condition whereas height (t=9.9, 11 df, p<0.01) higher in mist chamber condition. Height increment saturated October onwards till January because of climatic conditions prevailed in the study area and regain growth from February. This may be due to accumulated food reserves in the seedling during winter months which increase the growth. Field growth showed that survival was excellent and total planted seedlings alive two years after plantation. Only one seedling dried in March 2009 but in June, it was re-sprouted through persistence underground rhizome (Fig. 3). Plants were attained 1.8± 5.3 m height with 16.5± 1.6 culms plant^{-1} two years after planting. In first four months of planting the height increment was slow and growth started with the commencement of monsoon. This may be due to transplanting shock, drier summer conditions and investment of energy in the culms production. Rhizomes established much more frequently in the field than polybags.

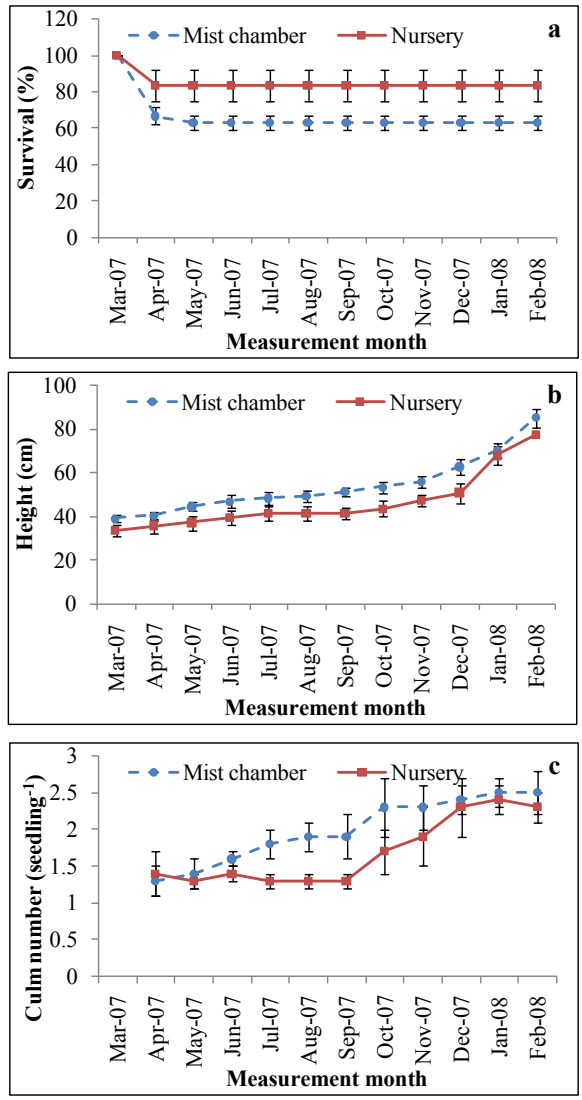
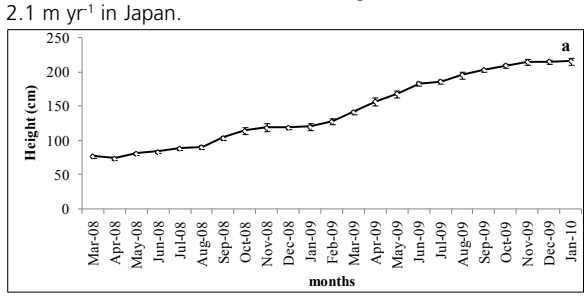


Fig. 2. Comparative growth and survival after one year of *P. pubescens* in mist chamber and open nursery conditions. (a) survival (%), (b) height (cm) and (c)culms number (seedling^{-1}). Error bars indicated ± SE.

Culms emergence started in the very next month of planting in field while in polybags no such growth was recorded because of limited space in polybags. After November onwards, both culms emergence and growth retards till spring when growth and culms emergence increased. This again indicated that control of environmental conditions on the growth of the species. The study also indicated that the species starts to spread and colonize the area through leptomorph rhizome system and initial planting spacing has been completely covered by the culms. Isagi and Torii (1997) reported that the average rates of expansion, measured by censusing current and old culms in the front of 10 unmanaged bamboo sites, were 2.1 m yr^{-1} in Japan.



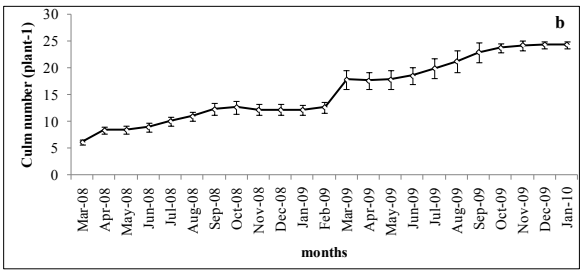


Figure 3. Two years (a) height growth (cm) and (b) number of culms (plant^{-1}) of *P. pubescens* in field condition. Error bars indicated ± SE.

Conclusion

This study indicated that the Moso bamboo, being exotic, in the state showed higher mortality in the initial, delicate and sensitive phase of lifecycle. The study also indicated that the species starts to spread and colonize the area through leptomorph rhizome system. Therefore, this initial trial on leptomorph, *P. pubescens* would be a milestone in the bamboo mission of the state Uttarakhand. This initial trial can be used as 'rhizome bank' to supply planting material without waiting for long gregarious flowering, so that greater economic and environmental benefits can be obtained.

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