INTRODUCTION
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Genus *Populus* includes of 29 morphologically diverse species of deciduous, relatively short lived and fast growing trees (Eckenwalder, 1996). The native range of *Populus* is North America, Europe, North Africa and parts of Asia growing mainly in riparian and mountainous habitats. However, poplars are now being cultivated in more than 100 countries. The traits of *Populus* which make it suitable for large scale plantations includes rapid growth rate, highly desirable wood properties for multiple wood based industries, high productivity on short rotations and good coppicing ability. Moreover, in *Populus* spp., phenotypically stable traits are readily produced using transgenic method so it has now been adopted as model tree for genetic studies (Ellis *et al.*, 2010). Molecular and bioinformatics resources are being developed for multiple species of *Populus* and the genus has become excellent system for studying tree genetics and genomics.

In India, *P. deltoides* is the only *Populus* species that is planted on a significant scale for commercial purposes. Various high yielding clones of this species are being grown on around 312,000 ha area in various agroforestry models in Punjab, Harayana, Uttar Pradesh, Himachal Pradesh, Uttarakhand, Jammu and Kaishmir and recently in Bihar (Dinesh Kumar and Singh, 2012). These plantations are fully owned by private smallholders in India (FAO, 2012). About 80 per cent of the wood from these plantations is consumed by the plywood industry. About 400 veneer and plywood manufacturing industrial units are located in Haryana state alone. Remaining 20 per cent goes to the match industry, pulp, paper and charcoal (FAO, 2012). Interestingly, waste material of poplars such as burr, root, leaves, branches and twigs are being used for energy.

In present situation, where there is increasing concern for environment and consequently restriction on felling of trees from existing forests, trees outside forests including social forestry plantations, are only source of sustained supply of wood to plywood and match industries. Poplar cultivation invites special attention of the researchers in view of its narrow genetic base. It is estimated that around 90 per cent area under poplar cultivation in India comprises only few clones. Clones G48, WSL 22, Udai, WSL 39, WSL 32, Wimco 81 and Wimco 110 together constitute over 90
per cent of the total planted poplar in the country (Dhiman, 2012). The growth of clone G3 (once regarded as the best clone) has declined due to its susceptibility to blight caused by Bipolaris maydis and that of G48 is also showing declining trend (Wani and Malik 2014). Now there is a need to increase the genetic base of Populus growing in plantation by infusing some more clones and to include native species through domestication and hybridisation. There are some potential indigenous species which require special attention for meeting growing demand of wood based industries. There are only four species of Populus, viz. P. ciliata, P. gamblei, P. jaquemontii var glauca and P. rotundifolia, which are considered to be indigenous to India (Naithani et al., 2001; Naithani and Nautiyal, 2012). Out of these indigenous species, P. ciliata and P. gamblei are useful fast growing species. P. ciliata wood is already tested and found suitable for plywood, hard boards, packaging cases and match making (FAO, 1979; Naithani and Nautiyal, 2012). Three out of these four indigenous species namely P. ciliata, P. jaquemontii var glauca and P. rotundifolia are found in temperate regions above 2000 m elevations (Naithani and Nautiyal, 2012). These can be grown on high altitude of Himalayas, but scope for their introduction on northern river valley plains which is main poplar (P. deltoides) growing region of the country, is limited. On the other hand, P. gamblei grows at relatively low altitude (600 m – 1200 m amsl) and it is reported to be the poplar that is naturally found very close to equator (around 27º N latitude). It is a fast growing tree and it produces high mean annual output from 16.3 m$^3$ ha$^{-1}$ to 35.9 m$^3$ ha$^{-1}$ with some valuable traits such as good stem form, deep penetrating roots, good natural pruning ability and resistance to draught and fire (Guhathakurta, 1973). Wood is used locally for temporary hut construction in shifting cultivation fields (Naithani and Nautiyal, 2012). Wood has been found suitable for plywood and match making (FAO, 2012).

These important traits of P. gamblei make it suitable for its incorporation into agroforestry systems and other social forestry plantations. The species has attracted attention from different worker and scientists in late 1970. Guhathakurta (1973) planted thousand of wildling (seedlings collected from natural forests) on three different sites viz. Sukna, Rajabhat Khawa and Gorubhatan areas of West Bengal. But, the success rate was very low (< 10.0 per cent) and only few seedlings could survive after end of the first growing season. Perhaps, the major impediment for successful introduction of the species on commercial scale is its propagation.
Propagation is difficult either by seeds or vegetative parts. Seed collection is difficult, as fruiting is non-synchronous and there is a very short time between seed maturity and seed dispersal (Beniwal and Singh 1989). Seed germination is recorded to be low (22%) though seed remains viable for about 600 days (Beniwal and Singh 1989). There is no report available about the natural regeneration status of this species. In fact, information regarding natural and artificial regenerations are totally unavailable. Low germinability and difficult rooting capacity are the main constrains of artificial regeneration of *P. gamblei*.

Guhathakurta (1973) tried to propagate this species through branch cuttings with the application of auxins, but no success was achieved. Gosh and Bhatnagar (1977) and Lahari (1979) could achieve a limited success with exogenous application of hormones. Thakur and Bisht (2009) attempted to propagate the species through establishment of culture from axillary bud sprouting, but *in vitro* rooting and complete plant regeneration could not be achieved. All the efforts made in the past to propagate *P. gamblei*, either through cuttings or mass propagation through tissue culture, had not considered the influence of maturity of apical meristem on rooting (known as cyclophysis) and efforts was not directed towards capturing juvenility either by using seedling explants or by using juvenile parts in older tree. Success in rooting, particularly in difficult to root species, is determined by maturity of explants used for making cuttings. Young and juvenile cuttings made from seedling, are easily amenable to rooting even in difficult to root species such as Eucalypts and Teak. In mature trees, juvenility can be promoted by coppicing and pruning. Rooting capacity of cutting made from coppice shoot is much better than branches on crown of the tree. Coppice shoots are commercially used for preparing cuttings in *Eucalyptus*. The present investigations “*Natural regeneration and propagation of P. gamblei Dode*” was proposed with following objectives:

- Studies on natural regeneration of *P. gamblei*
- Development of macro-propagation and micro-propagation protocol for *P. gamblei*
Macro propagation protocol was developed using different types of explants collected from different height of the tree. For increasing rooting success, different growing media were used and cuttings were treated with different types of auxins. To improve survival of rooted cuttings, cuttings were treated with different biofertilizers and observations were recorded on growth and survival at the end of first growing season. For mass propagation of suitable genotypes, complete tissue culture protocol was developed both for juvenile and mature explants. Tissue culture protocol included standardization of surface sterilization of explants, culture establishment, in vitro multiplication, in vitro rooting and hardening and acclimatization of in vitro grown plantlets.