

VEGETATIVE PROPAGATION ROOTING PRACTICES WITH FOREST TREES IN INDIA

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ABSTRACT

Plantations of most of the economically important forest species in India are usually established with seedlings, either by entire transplanting of nursery stock or by stump planting. Willows (*Salix spp.*) and poplars (*Populus spp.*) are the only forest trees which are widely planted as shoot cuttings. However, rooting of cuttings is also practised to propagate, on a small scale, *Bursera penicillata* (Sesse et Moc. ex D.C.) Engl., *Morus alba* L. and a few other forest tree species. Bamboos, which are an important forest component, are widely propagated by vegetative means. With forestry becoming more intensive the interest in vegetative propagation has increased. This has prompted laboratory and field studies, to improve existing techniques, and to extend vegetative propagation to other species, e.g., teak (*Tectona grandis* L.f.). This paper outlines methods already in use, and reviews the research on vegetative propagation which has been done at Dehra Dun and elsewhere in India.

INTRODUCTION

In the present-day context of intensive management of forest land, with the introduction of fast-growing exotics and genetic improvement of forest tree species, it is most important to develop fast and economical methods of raising superior stock. Vegetative propagation of forest trees is potentially very useful for replicating clonal material and for the multiplication of stock. Clones offer the advantages of genetic uniformity and the immediate availability of superior individuals for seed orchards and for plantations. Considerable efforts have been made in many countries to develop techniques of clonal propagation for tree improvement programmes and for field afforestation. Of various methods of vegetative propagation of forest tree species, the one most likely to succeed on a large scale is the rooting of shoot cuttings. Setting of cuttings can avoid the problems of seed collection and of ensuring germination and subsequent survival of young seedlings. Stem or shoot portions are generally very good material for rooting purposes, because they usually have undifferentiated tissues which may permit initiation of root primordia, and they also have buds already formed. The frequent early flowering of shoot cuttings can save time and makes the work of the tree breeder easier as he can work much closer to the ground.

There are numerous reports on the raising of shoot cuttings, e.g., Yin & Liu, 1948; Fielding, 1954; Ohmasa, 1956; Nienstaedt *et al.*, 1958; Schrieber, 1963; Thulin &

Faulds, 1968; McKnight, 1970; Hill & Libby, 1970. Poplars (*Populus* spp.), for example, are established in many countries mainly as shoot cuttings, and so is *Cryptomeria japonica* (L.f) Don, a valuable timber species in Japan. Various studies aimed at improving rooting techniques with forest tree species have involved the physiology of rooting, with particular reference to auxins and nutritional relationships (Snow, 1941; Mirov, 1944; Thimann & Behnke, 1947; Yim, 1962; Matthews *et al.*, 1960; Fielding, 1964; Libby, 1964; Bhatnagar *et al.*, 1968 & 1972; Nanda *et al.*, 1968 & 1970).

TREE ROOTING PRACTICES

Plantations of most of the economically important forest species in India are usually raised by entire transplanting of nursery-grown seedlings or by stump planting (i.e., using seedlings whose roots and shoots have been severely trimmed). However, in current practice in India, propagation of planting stock by cuttings is mainly used for establishing poplars and willows (*Populus* and *Salix* spp.). On a small scale shoot cuttings are also used to propagate *Bursera penicillata* (Sesse et Moc. ex DC). Engl. (Syn. *Bursera delpechiana* Poiss. ex Engl.) and *Morus alba* L. and occasionally *Platanus orientalis* L., *Tamarix* spp. and *Ficus* spp. Bamboos, although they are not really trees, are of great economic importance in Indian forestry; several species are raised by rooting planting stock by vegetative means.

Poplars

In recent years poplars have been increasingly cultivated. This genus is particularly evident in the Kashmir Valley and generally thrives between 1200 to 3050 m elevation. It becomes progressively less common towards the eastern Himalayas with increasing rainfall. Out of six species used, either indigenous or introduced, *Populus euphratica* Olivier and *P. ciliata* Wall. ex Royle are the most important (Seth & Desarkar, 1960). However, since 1958, over 180 species and hybrids have been introduced by the Forest Research Institute, then multiplied, and finally released for trials throughout India. More promising clones are *Populus* "casale 488", *P.* "casale 15", *P.* "casale 214", *P.* "casale 438", *P.* "casale 30", *P. robusta* Schneid., *P. regenerata* 410, and, more particularly, *Populus deltoides* (IC, and other clones) for the plains and *P. yunnanensis* Dode for the hills (Seth, 1969; Pande, 1973). Propagation by stem cuttings is the standard procedure (Champion & Seth, 1968). Cuttings of about 20-25 cm or longer are taken from the terminal shoots of main upper branches of the trees or from the specially raised stool beds. Branch cuttings also have given good results. The best period for taking cuttings is between November and March (Seth & Desarkar, 1960; Mathur, 1972). Cuttings are inserted vertically for their whole length in properly well-prepared nursery beds, preferably in sandy loam or sand with a high water table, at a spacing of 22 × 44 cm. Multiple shoots are reduced to one at an early stage. In the second year the shoots are cut back about 2 cm above the ground level and replanted in good soil at 40-60 cm spacing. By the end of the year they are ready for out-planting in the field. With hybrid poplars, longer cuttings of about 50 cm have given superior height growth.

Willows

Vegetative propagation is the standard practice with willows (*Salix* spp.). *S. tetrasperma* Roxb. is the most common Indian willow and it occurs between 1800 and 2200 m elevation. About five introduced species of willow are widely planted in India,

of these *S. alba* L. var. *caerulea* Sm. is commonly cultivated, mainly in Kashmir Valley, for the manufacture of cricket bats (Troup, 1921; Kaushik, 1961). Propagation is generally carried out by planting sets or shoot cuttings of various sizes from January to March, depending on the local weather. Shoot cuttings of 90 to 120 cm length and 3 to 5 cm thick are taken from healthy branches of mature trees and are cut obliquely at each end. They are planted in nursery beds, with a spacing of 90 × 60 cm. The cuttings are set 60 to 90 cm deep in the soil (Keng, 1957). More recently, to minimise the curve at the base of the shoot, a technique of raising the sets in the nursery is being practised. The shoots are grown into sets of 5 to 8 cm diameter at the lower end with a height of about 2.5 to 3 metres. Often, willows are used in irrigated plantations. Regular irrigated channels of about 0.3 × 2 m cross section are prepared at the planting site 6 to 4.5 m apart. Sets are planted in February-March in 40 to 60 cm-deep pits in the prepared channels in a triangular pattern (Kaushik, 1961).

Bursera

Bursera penicillata (Sesse et Moc. ex D.C.) Engl. is a small bushy tree introduced from Mexico. The species yields an aromatic essential oil used in soap and perfume production. Every part of the tree contains oil, the maximum concentration being in the pericarp of the fruit (Shyam Sunder, 1972). The species can be propagated both by seed and by branch cuttings. Propagation by branch cuttings is the easiest way for the multiplication of the species. Cuttings of 5 to 8 cm diameter and about 45 cm long are taken during the month of March just before the new leaves appear. The cuttings are generally hung vertically for a day to drain excess oil. Cuttings with one or two side branches on the top give good growth, and shown better crown formation than straight cuttings without branches. The lower end of the cutting is treated with Seradix B. Such cuttings are planted in pots filled with equal parts of soil and farmyard manure. Profuse watering is done for a few days. The cuttings take 10-15 days to root. Planting in the field is done soon after the monsoon begins (generally during July) in 60-90 cm cubical pits at a spacing of 7 × 7 m. A mixture of manure, soil and sand is used for filling the pits. Cuttings from male and female plants are planted in the ratio of 1 : 9 (Kaikini, 1968; Rao, 1971).

Mulberry

Of six species of mulberry which occur in India *Morus alba* L. is the most widely cultivated. It is a moderate-sized deciduous tree having many distinct varieties, or cultivars. The wood is used mainly for making hockey sticks, furniture, etc. This is the species of *Morus* which is used most for silkworm rearing in India (Troup, 1921). The tree is very easily propagated, either from seed or from cuttings. Branch cuttings about 22-30 cm long and 2 cm thick having 2-3 buds on them are taken from mature trees for rooting in the nursery. In some areas the usual practice is to bundle the cuttings and bury them under the soil, watering regularly until the buds sprout and produce a shoot about 5 cm long. Such sprouted cuttings are taken out for planting in pits or in furrows. Pit planting is preferred and is practised both in irrigated and dry cultivation areas. In dry cultivation areas cuttings are planted completely buried in prepared pits, in a slanting position, at the onset of the monsoon. With irrigated cultivation the planting is often done in furrows, during April-May.

Tamarix

Tamarix aphylla Karst., a moderate-sized tree of the semi-desert region, is often planted, as well as other *Tamarix* spp., as branch and stem cuttings (Champion & Seth, 1968). Cuttings about 1.5 cm thick and about 40 cm long are planted about 30 cm deep in prepared nursery beds during February-March. Nursery beds are watered regularly until the cuttings root. Such rooted cuttings are then planted in the field, around August of the same year.

Platanus

Platanus orientalis L. is a large deciduous tree, frequently cultivated in Kashmir Valley, between 600 and 2400 m elevation. The wood is generally used for boxes and small fancy lacquered articles, and also as fuel. This species is sometimes propagated as branch cuttings; the best type of cutting has proved to be a twig about 30 cm long with a good "heel" (a portion of the bark stripped from the parent stem). Such cuttings are then planted in the nursery several centimetres deep. Even large stakes root successfully (Troup, 1921; Datta, 1962; Champion & Seth, 1968).

Ficus

Stakes of several species of *Ficus* root well and are often planted for roadside avenues and for difficult sites. They should usually be planted before the monsoon so as to give as long a first growing season as possible (Champion & Seth, 1968).

ROOTING OF BAMBOOS

Bamboo is a very important raw material for paper manufacture, being suitable for high-grade pulp. The following species are commonly cultivated for paper manufacture: *Dendrocalamus strictus* Nees, *D. hamiltonii* Munro, *Bambusa arundinacea* Retz., *B. tulda* Roxb., *B. balcooa* Roxb., *B. nutans* Wall. ex Munro, *B. vulgaris* Schrad. ex Wendl., *Oxytenanthera monostigma* Bedd., *Ochlandra travancorica* (Bedd.) Benth. ex Gamble *O. rheedii* Munro, and *Melocanna baccifera* (Roxb.) Kurz (Ghosh, 1964 and 1969). Bamboos can be propagated by seed, by offsets, by division, or by stem or rhizome cuttings. The commonest method is by cuttings, usually termed "planting offsets". A one-year-old culm is severed obliquely, about 1 to 1.2 m from the ground, and, together with two or three nodes of its rhizome, is removed from the soil with the roots attached. The offsets are transplanted just before the rainy season. Propagation by division is carried out by dividing up the mass of rhizomes and transplanting the culms in small clumps of two or three with rhizomes attached. Transplanting is done immediately before the monsoon. Propagation by stem cuttings is carried out usually by cutting the culm (normally one year old) at or near the junction with the rhizome, and the roots grow from the lowest nodes. These cuttings are planted vertically or nearly so, the group of nodes at the base being completely buried in the soil. Some cuttings consist of two nodes with the intervening internode half buried more or less vertically in the soil. Another method (mainly with *Dendrocalamus strictus*) is to place the stem cuttings, consisting of one internode with a node at either end, horizontally in the ground. Such cuttings are covered with soil, leaving only the upper surface exposed. Propagation by rhizomes is carried out by cutting 15 to 30 cm-long sections of fresh living rhizomes of the preceding year and containing at least one bud. These sections are planted in the nursery beds (Troup, 1921; Krishnaswami, 1956). *Bambusa vulgaris*, a pantropical

bamboo, has been raised in an experimental plantation by rhizomes and also by culm cuttings (Somani, 1972).

EXPERIMENTAL APPROACH TO ROOTING OF CUTTINGS

Since commercial plantations have become an essential part of Indian forestry, there are now advantages in vegetative propagation for developing clonal material from superior individuals, for seed orchards and for large scale plantations. In view of this, laboratory and field studies are being carried out in the Plant Physiology Laboratory at the Forest Research Institute, Dehra Dun, to develop suitable techniques for vegetative propagation of some important indigenous and exotic species. Current investigations are mainly on the rooting of cuttings of teak, *Bombax ceiba* L., *Dalbergia sissoo* Roxb., *Eucalyptus tereticornis* Sm., bamboos, etc.

Teak is a major timber species which occurs naturally throughout Central and Southern India. It has also been introduced in the plains of Northern India where it grows well in many places. Large scale plantations of this species are being raised in the country by "stump" planting or by planting bagged seedlings. Much experimental work on rooting shoot cuttings of this species has been done by the author. Branch cuttings have been successfully rooted in the nursery. The results indicate that cuttings of about 1.5-2 cm diameter and about 20 cm long, taken from one-year-old branches of 25 to 30-year-old trees, root well if pretreated with 100 ppm indole-butyric acid (IBA) solution for 24 hours and set in sand-filled pots. Without the IBA treatment the cuttings generally do not root at all or root very poorly. This species has shown strong seasonal variation in rooting response. The cuttings root only if taken during March to May under Dehra Dun conditions. (Bhatnagar *et al.*, 1968; Bhatnagar & Joshi, 1972). Several rooted cuttings raised from each of several mother trees have been planted in the field for comparing growth rates and percentage survival; the results are very encouraging. Investigations on various other aspects of rooting are in progress and it is hoped that with further improvement this technique may be suitable for establishing seed orchards and plantations of this species.

Similar experiments are being conducted with *Bombax ceiba*, *Dalbergia sissoo* and *Eucalyptus tereticornis*. Rooting of shoot cuttings of these species also has been considerably increased with hormone treatments. These species also have shown seasonal variation in rooting. In *Bombax ceiba* rooting is much better if the cuttings are taken during March and April and in *Dalbergia sissoo* and *Eucalyptus tereticornis* shoot cuttings have rooted well during August and September. Some success has been achieved in rooting and raising plants from lignotuberous tissues of *Eucalyptus tereticornis* (Bhatnagar & Joshi, 1973).

Trials on rooting culm cuttings of the bamboos *Dendrocalamus strictus* and *Bambusa polymorpha* Munro have shown that horizontal planting of cuttings gives good rooting (Madan Gopal & Pattanath, 1972).

Nanda and his co-workers (1968, 1970 & 1972) have studied the physiological basis of rooting in shoot cuttings of some forest tree species of India. Their work includes the gross rooting response to different auxins, internal and external factors affecting rooting, histological and biochemical changes, and the mechanism of auxin effects on root initiation and development. They have achieved good rooting in some important forest species, viz., *Populus* spp., *Salix* spp., *Dalbergia sissoo*, *Morus alba*, *Aesculus indica*

Colebr., *Toona ciliata* Roem., *Platanus orientalis*, *Lagerstroemia parviflora* Roxb., *Bauhinia variegata* L., and *Ficus* species.

Extensive branch cutting trials of *Cryptomeria japonica* have been undertaken in West Bengal forests (Neogy, 1970). Large numbers of cuttings have rooted and are growing well in the field. Late April or early May is reported to be a suitable period for setting the cuttings.

Experiments have been reported by many other workers on vegetative propagation of forest trees in India. Some other important species successfully rooted are given below (Kadambi & Dabral, 1954; Dabral & Ghai, 1961; Chaudhary, 1961 and 1963; Kedharnath & Dhaundiyal, 1963): *Ailanthus excelsa* Roxb., *Agathis robusta* (C. Moore) F. M. Bailey, *Araucaria cunninghamii* D. Don, *Boswellia serrata* Roxb., *Bischofia javanica* Bl., *Broussonetia papyrifera* Vent., *Casurina equisetifolia* Forst., *Cinnamomum camphora* Nees & Eberm., *Chukrasia velutina* Wt. & Arn., *Dalbergia latifolia* Roxb., *Garuga pinnata* Roxb., *Gmelina arborea* Roxb., *Hymenodictyon excelsum* Wall., *Lannea coromandelica* (Houtt.) Merr., *Michelia champaca* L., *Pinus roxburghii* Sarg., *Pterospermum acerifolium* Willd., *Shorea robusta* Gaertn. f., and *Terminalia myriocarpa* Heurck & Muell-Arg.

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