Clonal propagation for yield improvement in forest plantations.

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ABSTRACT

The last two decades have witnessed a significant progress in the development of clonal approaches to yield improvement in forestry, both for pulp and timber. This paper reviews the recent achievements of Plant Physiology Discipline in clonal propagation of *Eucalyptus* hybrid, *Gmelina arborea*, *Casuarina equisetifolia* and bamboos. The possibilities of extending these approaches to several more tree species and improvement of yield and quality in forest plantations in the light of recent developments in clonal forestry, are discussed.

Introduction

Clonal propagation is one of the most effective tools for tree improvement in forestry. Improvement of woody plants through breeding, including hybrididization, is rather difficult because of their long generation time, prevalance of out breeding and the operational difficulties. This has led to an increase in the research efforts directed towards development of techniques of vegetations propagation for raising clonal plantations and, thereby, exploiting the vast genetic variation already existing in the natural populations. Since vegetative propagation provides an opportunity to harness and exploit genetic varition directly, it could also make investment more attractive in forestry by (i) improving the yield and quality, (ii) shortening the rotation period, (iii) allowing some of the biological problems hindering reforestation to be circumvented, (Leaky,1987 : Pal, 1988). Using clonal approaches, Brandao et al , (1984) achieved 135% improvement in productivity from *Eucalyptus* plantations raised for obtaining raw materials for paper mill. Clonal planting of *Gmelina arbones* and *Triplochiton sceroxylon* and *Terminalia superba* can decreased forking of the trunk and improved wood quality and tree growth (Akachuku, 1984; Leaky, 1987). Besides these benefits clonal approaches can improve biotic and abiotic stress tolerance of the plantations. Hence, in the coming years, the shift to raising clonal plantations using vegetatively propagated elite materials is likely to become more compelling.

Technical developments in clonal propagation

For raising clonal plantations, the first step is to develop suitable vegetative propagation techniques for mass multiplication of the clonal material. Since rooting shoot cuttings has the advantage of being the most convenient, rapid and cost effective of known methods of vegetative propagation, studies were taken up to find out suitable techniques for rooting stem cuttings of several important pulp yielding to forest tree species. More important findings from some of these investigations have been briefly reviewed in this paper.

Eucalyptus hybrid

Detailed technique for clonal propagation of *Eucalyptus* hybrid by rooting nodal coppice shoot cuttings have been worked out (Gurumurti et al., 1988;

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1989). The selected trees are felled in the month of February to encourage growth of the coppiced-shoots. Coppiced-shoots are collected in the month of April, made into binodal cuttings, the leaves are trimmed to reduce leaf area to about 50% and the coppiced shoot are dipped in 0.1% Emison for 15 minutes. Immediately after it, the basal end of the cuttings is treated with 4,000 ppm of indole butyric acid (4 gram IBA in 1 kg. ordinary talcum powder) by basal dip method and planted in sand or vermiculite under intermittent mist with temperature ranging from 25°—35°. The cuttings root in about 4-6 weeks. These are transplanted in polybags, hardened off in shade house and are ready for outplanting by the month of July. Detailed plan for production of 50,000 clonal plants per year have been prepared (Gurumurti et al., 1989). Further, it has been observed that rooting response of the nodal cuttings varies with the clone, the age of coppiced shoot, the position of the coppice shoot on the stump, the maturity of the stock plant and auxin treatment. Depending upon the clone, best results in rooting are achieved using 2-3 month old coppice shoots, during April to June. Mother plants younger than 5 years in age produce vigorous coppice shoots which are easy to root; the coppicing ability and rooting potential of coppiced shoots declined in the older trees. Clonal material showed about 15% higher growth rate than the seed-raised plants at the end of 1 year of the field trial, Several cheap substitutes of auxins, mostly phenolic compounds have been found which not only reduce the cost of clonal propagation, but also improve the growth of root system.

Gmelina arborea

Hard-wood cuttings of *Gmelina arborea* were found to root under partial shade. Treatment with indole butyric acid (IBA) improved rooting. Rooting respones of hard-wood cuttings is superior during March to June. Cuttings taken from mature trees fail to root. While hard-wood cuttings take more than 2 months to root, leafy softwood nodal coppice shoot cuttings root within 3-4 weeks, under mist. At the end of first year, the clonal material from juvenile plants exhibited superior growth than the seedlings, but the vegetative propagule obtained by rooting cuttings from mature trees showed poor growth.

Casuarina equisetifolia

A technique has been developed by which very small segments comprising about 3.0 cm pieces of needle like cladodes of *Casuarina equisetifolia*, can be rooted. This technique is very useful for mass production of the clonal material, rapidly. For vegetative propagation healthy, vigorously growing needle-like cladodes are collected, made into small cuttings, about 3.0 cm or longer in size treated with auxin by basal dip method, planted in vermiculite or sand and maintained under intermittent mist in a mist chamber The daily day-night temperature fluctuation in the mist chamber was 35°C—25°C. The cuttings root in about 20-30 days. It was observed that even 3.0 cm long segments rooted, but rooting percentage generally increased with the length of the segments. Rooting response of cladode segments varied with the clone, the season of taking and planting the cuttings, the maturity of the mother plants, and the treatment of the cuttings with growth regulatory substances. Some clones were very easy-to-root and the cladode cuttings taken from such clones exhibited about 90% rooting, but some other clones were relatively difficult-to-root and the cladode cutting prepared from such clones failed to root without auxin treatment. In general, rooting was more profuse during summer months, from May to July. Indole butyric acid and naphthalene acetic acid treatments stimnlated rooting, their optimal doses being 5,000-10,000 ppm, depending upon clone and season of taking the cutting. Cuttings taken from younger, 2-3 old saplings, rooted more easily and profusely than these taken from more mature, 15-20 years old, trees. Since rather higher auxin dose was required for stimulation of rooting, investigations were taken up to find cheap substitutes of auxins to raduce the costs of vegetative propagation. It has been observed that several non-auxinic chemicals, mostly phenolic compounds strongly stimulate auxin-caused promotion of rooting and that these chemicals can substitute auxin requirement for optimal rooting by 80-90%. Since these chemicals are very cheap, their use in combination with lower doses of auxins will reduce the cost of vegetative propagation of clonal material. Further, the root system developed on cuttings as a result of their treatment with a mixture of lower dose of auxin and the phenolic substitute is found to be more vigorous than the root system developed on cuttings which were treated with auxin alone. The vegetative propagules exhibit good growth in the field trials (Pal and Bhandari, 1991).

Bamboos

Since the most of commercially important bamboo flower greagariously and produce seed after very long periods, generally 2-3 times in a century, and the seed remains viable for only about one year, the bamboo plantation programme suffers due to lack of adequate and timely supply of seed material. Hence, vegetative propagation of bamboos is very important to raise the planting stock. offset planting and rooting culm cuttings have been traditionally used for vegetative propagation of bamboos (Kumar, 1989). However, these methods are very laborious and the success rates in the field are also not satisfactory. Recent investigations in Plant Physiology Discipline have led to development of a new method of vegetative propagation through macro-proliferation of sympodial bamboos (Kumar et al., 1991, Kumar, 1992). The four immportant bamboos which have been successfully multiplied using this method, are *Bambusa arundinacea*, *Bmbuds tulda*. *Dendrocalamus stricts* and *Dendrocalamus hamiltonii*. Macro-proliferation involves raising bamboo sedlings using seed, stimulating the growth of tillers and rhizome with the help of optimal nutrient doses, tiller separation and their planting in suitable medium during appropriate season and boosting the growth of the propagules By repeating the process twice a year first, during the months of July and then in April the seedling stock of *Bambusa arundinacea*, *Bambusda tulda*. *Dendrocalamus strictus* and *Dendrocalamus hamiltonii* can be vegetatively multiplied 49, 25, 36 and 16 times respectively, every year. The method totally eliminates the dependence on bamboo seed from the second year onwards for mass production of field plantable bamboo saplings. Detailed plan have been prepared and presented (Kumar, 1991) for continuous production of field plantable saplings of these four bamboos on operational scale. The macroproliferation method for vegetative propagation of bamboos is simple, easy and ensures satisfactory field performance of the prapagules.

Tropical pines

Investigations on clonal propagation of tropical pines have revealed that *Pinus caribaea* can be vegetatively propagated using brachiblast cuttings from juvenile trees. Shoot apical zone of the main branch and prominent lateral branches is injured to encourage the growth of brachiblast shoots. The brachiblast shoots are collected in the month of July, made into soft-wood cuttings, treated with auxin and planted under mist. Root formation takes about 3 months. 2000 ppm indole butyric acid of naphthalene acetic acid were the most effective treatments for the rooting of brachiblast cuttings.

Future prospects

Since the basic clonal propagation techniques are now at a stage where they can be used directly, or with some easy modifications to suit other species or situations, the future developments will depend more on the policy decisions of user agencies. Clonal propagation is very vital to yield improvement in multipurpose agroforestry species, which is very difficult to be achieved through traditional breeding considering the number of end uses expected from such species The multipurpose species, like *Azadirachta indica*, *Melia azedarach*. *Prosopis juliflora*, *Leucaena leucocephala*, willows etc can now be vegetatively propagated using techniques developed in Plant Physiology Discipline. Economic worth of non-cellulosic components, like leaf and bark, obtainable from multipurpose tree species would make raising paper pulp plantations financially more profitable. Such species also need to be considered more seriously in clonal forestry.

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