# Recent Advances in Forest Tree Cuttings©

**Takayuki Asada and Masaru Shibata**
Oji Paper Company Ltd. Forestry Research Institute, 24-9 Nobono-cho Kameyama, Mie 519-0212

## INTRODUCTION

Dear I.P.P.S. members, do you have any problems propagating woody plants by cuttings? We in the forest industry have trees, such as *Eucalyptus*, which are widely planted for pulpwood by paper-making companies that are difficult-to-root species. Today's nursery techniques for the mass vegetative propagation of *Eucalyptus* for plantations are well summarized by Eldridge et al. (1993). The encyclopedic information compiled by the International Plant Propagators' Society, in the Combined Proceedings (the black book) would be one of the best if you had only one propagating source. An additional information resource would be the World-Wide Web bibliographic patent databases offered by the Japanese patent office. This article will review recent advances in forest-tree cutting propagation, especially focusing on the technology published in the Japanese patent database.

## RECENT ADVANCES IN FOREST-TREE CUTTING PROPAGATION

**Environmental Factors.** The importance of environmental factors affecting cutting propagation has been widely recognized (Christie, 1998; Eigenraam, 1998) and some advanced technology can be found in the Japanese patent database. Sakai and Yamamoto (1996) showed an apparatus for rooting cuttings of *Shorea*. In this apparatus, cuttings were arranged in propagation boxes (Fig. 1A) equipped with a propagation bed and watering mist for maintaining high humidity (90% to 100%) and hermetically covered with a material for transmitting sunlight and spraying fog (a fine mist) in a greenhouse (Fig. 1B), cooling the greenhouse with the heat of vaporization of fog to regulate the interior temperature of the greenhouse at an optimum (28 to 30°C). Temperature regulation by the production of fog was controlled with a temperature-sensing on-off switch driving a fog-producing pump. A shade cloth was provided in the upper part of the greenhouse to properly limit the quantity (5000 to 20,000 lux) of sunlight in the greenhouse.

Kozai et al. (1998) produced young plants by transplanting explants of an arborescent plant of *Acacia* into a sugar-free medium and culturing in the presence of increased carbon dioxide under illumination. The culturing was carried out at a carbon dioxide concentration of 350 to 500 ppm in the culturing vessel and illuminated at a photon flux density effective for photosynthesis of 150 to 300 µmoles $m^{-2}$ $s^{-1}$. Murakami et al. (1995) also accomplished a mass production of *Eucalyptus* clonal seedlings with a similar technique. They transplanted sterile-raised young plants into a porous medium wetted with a liquid medium containing inorganic salts but no carbon source, and then subjected them to rooting and acclimatization at a relative humidity of 70% to 100% in the presence of carbon dioxide at a concentration of 200 to 3500 ppm. The promotive effect of carbon dioxide has been shown by these studies but cost might be a problem for practical applications.

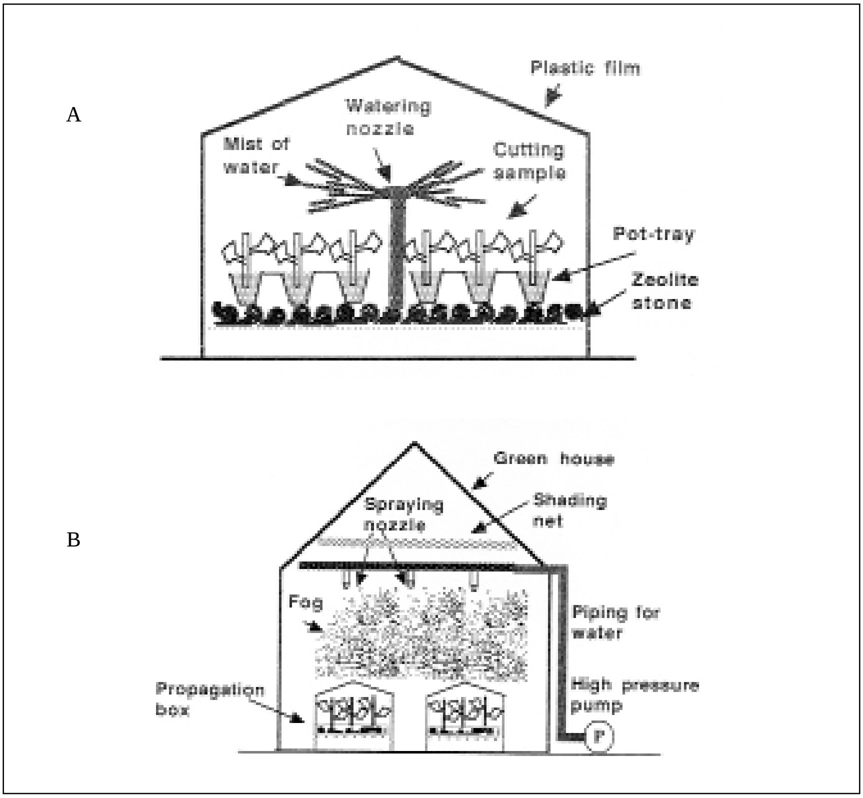


**Figure 1.** (A) Cuttings are arranged in propagation boxes equipped with a propagation bed and watering mist for maintaining high humidity, (B) and hermetically covered with a material for transmitting sunlight and spraying fog in a greenhouse.

With environmental factors, light is essential for photosynthesis and so seems to be essential for rooting but it has a minus for temperature control. The most suitable irradiance level may vary according to the species. Heuser and Zaczek (1998) in a recent study with typically difficult-to-root mature tree species of *Quercus* and *Acer* suggested that high levels of shade (up to 97%) applied in the rooting environment could prove to be useful in the rooting of cuttings. Therefore the more advanced control techniques of natural daylight might be required for forest tree cuttings.

**Physiological Conditions of the Stock Plants.** The importance of stock plant environment has also been well recognized because the physiological condition of the stock plant has a significant influence on rooting (Christie, 1998; Eigenraam, 1998). Hoad and Leakey (1996) found that rooting percentage was better with cuttings from *E. grandis* stock plants grown at lower red to far-red ratios with light qualities at a constant photon flux density. They demonstrated that stock plant environment may significantly modify the morphology and physiology of subsequent cuttings, and that cutting morphology and stored and current photosynthates have a significant influence on rooting.

Byrne (1996) presented a method of vegetative propagation which comprises developing etiolated shoots on stock plants by immersing a stock plant horizontally in a bed that contains a growing medium, removing shoots after they have reached a semi-hard state, and placing the shoots in a high-moisture environment until rooting. These advances must be seen in terms of theory which would contribute to future technology.

**Rooting Hormones.** Rooting hormones such as indole-3-butyric acid (IBA) and naphthalene acid (NAA) have been found to be reliable in the promotion of rooting in cuttings and are widely used. There are two directions of recent advances in rooting hormones: One is the improvement of effect by modifying their chemical structures, and the other is the development of new hormones.

Marumo et al. (1987) synthesized some indole-3-acetic acid (IAA) derivatives, e.g., methyl 4,5-dichloro indolyl-3-acetic acid, and demonstrated that they showed comparable activity to IAA or IBA at lower concentration. Much higher activities of such derivatives may be ascribed to their lower decomposition rate than native IAA.

Sasaki et al. (1992) provided a plant rooting promoter containing, as active ingredient, an adenine derivative represented by the formula showed in Fig. 2 (wherein n is 1 or 2 and R and R' represent hydrogen or a methyl, ethyl, allyl, or propyl group), e.g., N'- [2-(N-methoxyimino) propyl] adenine (MPA). They cultured sterilely raised *Quercus acutissima* shoots in a medium containing MPA, and resulted in a higher rooting percentage than IBA.

Sakai et al. (1994) obtained a plant growth controlling agent having synergistic activity and capable of exhibiting strong plant growth controlling activity. This plant growth controlling agent contains an epoxy cyclohexane derivative represented by the formula showed in Fig. 3 (wherein $R^1$ is hydrogen, a 1-6 C alkyl or a 3-6 C cycloalkyl; $R^2$ and $R^3$ are each a lower alkyl or together form polyethylene which optionally substituted with an alkyl), e.g., 4,4-ethylenedioxy-1-{4-(hydroxycarbonyl)-1-hydroxy-3-methyl-3-buten-1-yl}-1,2-oxo-2, 6,6-trimethyl cyclohexane and a brassinosteroid, a compound represented by the formula showed in Fig. 4 (wherein $R^4$ and $R^5$ are each a lower alkyl), e.g., (22R, 23R, 24S)-2 α,3 α-dipropionyloxy-22,23-epoxy-β-homo-7-oxa-5 α-stigmastan-6-one, as active components.

**Other Chemicals.** Silver nitrate is a chemical having anti-ethylene activity. Silver ions, used at $10^{-4}$ to $10^{-3}$M, inhibit the response of plants to endogenous and exogenous ethylene (Dawson et al. 1986).

Matsuhira and Sukeno (1998) provided a method for rooting cuttings of a plant

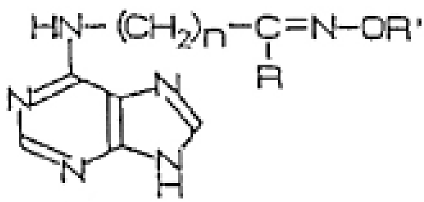


**Figure 2.** A plant rooting promoter containing, as active ingredient, an adenine derivative.

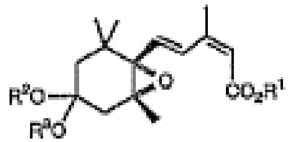

**Figure 3.** A plant growth controlling agent contains an epoxy cyclohexane derivative.

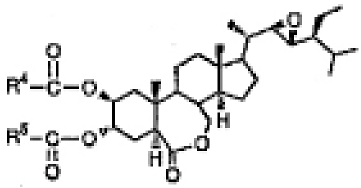

**Figure 4.** A brassinosteroid plant growth controlling agent.

belonging to a genus in the *Betulaceae* by dipping the scion base in a 500-2000 times diluted solution of silver nitrate as a preliminarily treatment of the basal portion to a rooting stimulating treatment and then treating the preliminarily treated portion with IBA.

## CONCLUSIONS

The newer technology described here, with controlling environmental factors both in stock plants and rooting cuttings, and hormones or other chemicals, are capable of more stable cutting production of forest trees. However, there are still difficult-to-root forest tree species. Further research will clarify which is the better technique for cuttings propagation and significant advances in technology will offer an optimistic future in this field.

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