Cutting Propagation of Leyland Cypress
(X*Cupressocyparis leylandii*)©

Heike De Silva

Soil, Plant and Ecological Sciences Division, PO Box 84, Lincoln University, Canterbury

INTRODUCTION

Leyland cypress (X*Cupressocyparis leylandii* Jacks. & Dallim.) is an inter-generic hybrid between macrocarpa cypress (*Cupressus macrocarpa* Hartw.) and Alaska cedar (*Chamaecyparis nootkatensis* D.Don) (Franklin, 1997). Leyland cypress has become a popular tree species mainly because it is easy to establish and grow. It tolerates a wide range of sites and soils (from acid to alkaline, from clay to sand) as well as salt-laden winds, which makes it suitable for planting in coastal areas. The species is frost hardy and has survived frosts of up to -20ºC in the Southwest of the United States. Growth rates are relatively high especially in moist, fertile soils and the plants respond well to trimming (Dirr, 1983; Ovens, 1968).

Historical Background. In 1888 six unusual seedlings were noticed by Mr. C. J. Leyland at Leighton Hall, Welshpool in Wales, United Kingdom, where a number of trees from all over the world had been planted in an arboretum. These new hybrids were later transplanted to Haggerston Castle, Northumberland, where during the early 1900s Mr. Leyland and his son, J. M. Naylor, continued to develop new trees. In 1911 two more seedlings were derived from Leighton Hall, one of which developed into the popular cultivar 'Leighton Green'. In 1925 specimens propagated at Haggerston Castle were brought to the attention of Dallimore and Jackson at Kew Gardens in London, who published a botanical description the following year. An additional two seedlings originated in a garden at Ferndown, Dorset in 1940 (Clark, 1988;Dirr, 1983; Sturrock, 1972). Since that time, many cultivars have been selected, which differ in growth form and colouration of the foliage.

Leyland Cypress in New Zealand. In 1952, Leyland cypress 'Leighton Green' was the first cultivar to be introduced into New Zealand, mainly to replace macrocarpa cypress tree stock, which is highly susceptible to the fungal disease cypress canker (*Seiridium* species) (Sturrock, 1989). Leyland cypress has become very popular for planting as windbreaks or shelterbelts. There is also an increasing interest in Leylands as a timber species, especially in agroforestry situations. A survey conducted by New Zealand Forest Research of nurseries supplying cypress plants in general showed that at least 11 million plants have been sold over the last 10 years, which represents a minimum area of 9000 ha established over this period (Barrill, 2001).

PROPAGATION

Seeds of Leyland cypress are virtually infertile. Any possible chance seedlings that may arise would probably not be true-to-type. Therefore cutting propagation currently represents the main form of propagation for this species (Russell, 1993).

The importance of using juvenile plant material for propagation was demonstrated by Halliwell (1970) who obtained a rooting percentage of 94% for cuttings taken from a 5-year-old tree compared to only 34% strike from a 20-year-old and 5% strike from a 50-year-old tree.

The problems associated with the propagation of Leyland cypress are: (1) variation in rooting success, (2) excessive callus formation, and (3) poor root symmetry. Great variation in rooting occurs among cultivars (Blythe, 1989) and times of year when cuttings are taken (Dirr, 1983). In a study by Dirr and Heuser (1987), rooting percentage was 71%, 57%, and 51% for 'Haggerston Grey', 'Leighton Green', and 'Naylor's Blue', respectively.

Often, Leyland cypress cuttings may produce only callus. Others may form roots only on one side of the cutting base. These cuttings are not suitable for transplanting since the lopsided roots would not be able to anchor the plant firmly in the ground. All cuttings that have not produced any roots or have roots with poor symmetry must be retreated and reset, which means that the cuttings spend more time in the nursery before they can be sold, resulting in additional costs for materials and labour.

Wounding of Basal Tissues. Wounding of cuttings has been used as a successful technique to promote root formation in cuttings of many plant species. It provides an increased surface area for the absorption of water and hormone solutions and stimulates the production of ethylene, which is known to promote adventitious root formation. Wounding also encourages the basipetal movement of carbohydrates and endogenous auxins to the wounded area at the base of the cutting. For these reasons, wounded cuttings often produce better and stronger root systems compared to nonwounded cuttings (Edwards and Thomas, 1979; Hartmann et al., 1997).

Rooting hormones. Indole-3-butyric acid (IBA), a synthetic auxin, has been used commercially since its discovery in the mid 1930s. It is known to promote root formation in cuttings of many species (Edwards and Thomas, 1979; Kroin, 1992). Root formation in cuttings involves a sequence of stages that can be divided into two main phases: (1) root initiation and (2) root growth and development (Wilson and van Staden, 1990). Auxins have been associated with division and elongation of meristematic cells, differentiation of root primordia as well as mobilisation of carbohydrates to the base of the cutting (Bhattacharya, 1988). Auxins are only essential during root initiation, and have an inhibitory effect on root elongation (Drew, 1991).

Recommendations for IBA concentrations for rooting of Leyland cypress cuttings are conflicting. Hartmann et al. (1997) recommended 3,000 ppm for cuttings taken from spring to autumn and 8000 ppm for cuttings taken in winter. Dirr and Heuser (1987) reported that summer cuttings were rooted successfully when treated with 10,000 ppm IBA. In contrast, Powell (1993) found that cuttings taken in spring rooted almost 100% at 5000 ppm IBA and produced less callus than those treated with 8000 ppm IBA. Dirr and Frett (1983) reported 90% rooting success for cuttings treated with 8000 ppm IBA while concentrations of 16,000 and 32,000 ppm resulted in foliar necrosis and the cuttings did not recover after transplanting. However, no detailed information was given on experimental protocols. As rooting success is influenced b a number of factors such as cutting source, age of the ortet, season, propagation environment and propagation medium, it is not possible to compare any of these recommendations.

MATERIALS, METHODS, AND RESULTS

To investigate the effects of wounding treatments and hormone applications on rooting of callused Leyland cypress cuttings, an experiment was carried out in collaboration with Southern Woods Nursery, Templeton, New Zealand. The cuttings had originally been taken from 5-year-old stock plants and set approximately 3 months prior to our experiment. Only callused cuttings that had not produced any roots were used for this study. Combinations of different wounding treatments (no wound, single wound, and double wound) and IBA applications (0, 5000, and 10,000 ppm IBA) were applied prior to the resetting process. A double wound (a cut was made through the callus tissue along the stem on opposite sides of the cutting base) in combination with 10,000 ppm IBA increased percentage strike by 47% compared to the control. The mean number of primary roots produced increased from 0.7 for the control to 3.7 roots per cutting. The percentage of cuttings that developed roots with good root symmetry was 39% higher than the control treatment.

DISCUSSION

Callus Formation. Callus forms following the wounding of a cutting. A plate of necrotic tissue forms to prevent the penetration of pathogens (Hartmann et al., 1997). In some genera such as *Taxus*, and species such as *Araucaria heterophylla (*syn. *A. excelsa), Pseudotsuga menziesii,* and *Pinus radiata* the cell division continues until a large external callus is formed (White and Lovell, 1984). Roots often emerge through callus tissue and callus is therefore often considered to be a precursor of root formation, however this process is independent of root formation (Spethmann, 1998). In *Chamaecyparis, Cupressus,* and *Cryptomeria* species, for instance, roots are initiated in the cambial and phloem portions of ray tissues and grow outward through other stem and callus tissue (Hartmann et al., 1997).

Certain cells in potential sites need to acquire competence in order to form root primordia. This process of acquiring competence may be dependent on active enzymes, which may be lacking in difficult-to-root species (Hartmann et al., 1997).

The formation of excessive callus tissue may also be a result of a hormonal imbalance, especially lack of endogenous auxins and/or high levels of endogenous cytokinins, which may prevent the initiation of roots (Hartmann et al., 1997). This theory would, however, not explain why cuttings treated with 8000 ppm IBA produced more callus than those treated with 5000 ppm IBA as stated by Powell (1993). Wiesman and Lavee (1995) reported that the application of IBA alone was sufficient to promote rooting in easy-to-root olive cuttings, however, difficult-to-root cuttings only produced callus cells at the cutting base and no differentiation of cells into root initials occurred. Haissig (1982) reported that the action of the endogenous root-forming substances (auxins and non-auxins) on the initiation of root primordia occurs later in callusing species than in noncallusing species. This may be due to either a delay in the basipetal movement of these substances or a delay in the actions of these substances on primordium initiation. Spethmann (1998) states that physiological condition of the cuttings, for instance, degree of stress, and suboptimal environmental conditions during propagation such as humidification, may also contribute to callus formation.

Rooting. The formation of adventitious roots on a vegetative part taken from a plant requires a predisposition to form root primordia, while the propagule is still attached to the parent plant. This predisposition to form roots is a product of inter-actions between the genotype and the environment (Bhattacharya, 1988; Haissig et al., 1992). Therefore rooting success is directly linked to the time of year when cutting material is taken. In addition, the activity of auxin oxidase enzymes as well as phytohormones such as cytokinins and gibberellins may also vary with the sea-son (Edwards, 1978), thus influencing the effectiveness of applied synthetic auxins (Bhattacharya, 1988). This may explain the variation in optimal hormone levels for rooting of Leyland cypress cuttings in various studies.

Wiesman and Lavee (1995) noted that the use of IBA resulted in an increase in primary roots per cutting in olives. Spethmann (1998) argues that the application of growth hormones affects rooting time and enhances root quality parameters such as root number and position of primary roots, but does generally not influence root-ing percentage. This was not true for rooting of callused Leyland cypress cuttings in our experiment, as the rooting percentage was increased by the application of 10,000 ppm IBA. There appears to be, however, a difference in response to hormone application between easy- and difficult-to-root cuttings. In the late 1950s Hess demonstrated that endogenous substances other than auxins, so-called rooting cofactors, are involved in root formation. Co-factors such as sugars, amino acids, and oxygenated terpenoid compounds are located in leaves and buds and move downwards after excision and accumulate in the base of the stem to stimulate root initiation. It was concluded that all rooting co-factors are present in easy-to-root cuttings while one or more co-factors may be missing in difficult-to-root species, which may render synthetics auxins ineffective (Hartmann et al., 1997).

Wounding also positively influenced rooting in callused Leyland cypress cuttings. It appears that a larger wounded surface provides an increased contact area be-tween cutting base and growing medium to increase water absorption to maintain turgor in the tissues (Loach, 1988). Wounding also results in an increased produc-tion of ethylene (Lin et al., 1990), which is considered to act as a trigger for root initiation. An increase in ethylene during in vitro rooting of hazelnut (*Corylus avel-lana*) cotyledons was noticed during periods when cell division for callus nodules began (Gonzalez et al., 1991).

There are a number of factors that may be responsible for observed variation in rooting of Leyland cypress cuttings. This review concentrated only on genotypic conditions and their interaction with wounding and rooting hormones. The propa-gation environment (light, temperature, humidity, etc.), season, and condition of stock plants also play an important role in rooting success. The optimum range of environmental factors is much narrower in difficult-to-root species than in easy-to-root species. It is therefore advisable to record treatments as well as growing condi-tions for each season and cultivar to be able to compare the results and develop an optimal propagation environment.

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