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A Review On The Advancement Of Rooting In Eucalypts

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Abstract: Eucalypts are extremely important from a commercial view point due to their rapid growth, relatively short rotation period and their ability to grow in less than ideal soil conditions. Proper research on the root system of eucalypts will further increase vegetative propagation. Understanding what affects the process of rhizogenesis in vegetative propagation of eucalypts and how to root system adapts to varying soil conditions will make the process of clonal multiplication more viable.

Keywords: Eucalypts, root architecture, vegetative propagation, root system, mini cutting, Eucalyptus.

I. INTRODUCTION

Eucalypts belonging to the Myrtaceae family have become a widely grown plantation species due to their rapid development. Majority of its uses result from its rapid growth and short rotation period. For trees to be commercially successful they need to produce good quality wood and other non-wood forest products in a short amount of time and for this to be achieved trees need to overcome various physiological and environmental barriers. For successful anchorage trees require a well developed root system. The mechanical strength provided by roots is important in preventing overthrow of trees (Kramer, 1995). Stability of soil on slopes is also increased by roots (Hellmers, 1955). Nutrients in soil are usually distributed in an uneven manner which makes the formation of a well developed root system crucial in the survival of plants. Root architecture determines the tree’s ability to utilize the nutrients spread in the soil as well as determines its efficiency in absorption of water. The bulk of research focuses on the visible part of the plants while minority being directed towards the hidden half of the plant system. The reason for this is that roots are difficult to observe and study. The difficulty in studying root system occurs due to the fact that removing soil often risks damaging the original root structure and disrupts the architectural pattern of the root system. The study of root system is essential in Eucalypts due to their high economic value.

II. REVIEW OF LITERATURE

The easiest method of studying root system in plants is by inducing rooting in cuttings. For large scale vegetative propagation successful induction of rooting is essential. Altamura (1996) considered herbaceous plants to be easy-to-root while woody plants are recalcitrant and thereby are hard-to-root. A balance between the functions of roots and shoots often lead to the most efficient overall development of the plant. Neither the root nor the shoot should suffer deficiencies in supply of essential nutrients (Kramer, 1995). Mengel and Barber (1974) suggested that development of fruits and seeds sometimes reduces root growth. In a similar manner any damage to the root system will inevitably lead to reduced absorption of water and nutrients and ultimately inhibit shoot growth. To this end researchers from all over the world developed various methodologies to study the hidden half of plants.

According to Kramer (1995) it was Duhamel du Monceau who first began observing root systems around 1764-1765 and others have since followed in his footsteps. The oldest considered method for observing roots is total excavation. Schuurman and Goedewaagen (1971), Kirbi and Rackman (1971) described the Pinboard method which uses a wooden board with grid made of metal pins driven into the surface of the trench wall and it holds the roots in a natural position while the soil around the root is gently removed. Coring is another method which was described by Barber (1971) which determines the length of the roots and the weight of roots in the soil sample by using an auger to extract soil. Rogers (1969) and Atkinson (1983) both described underground chambers with windows against the soil called Rhizotrons. It provided researchers a unique opportunity to observe the change in the pattern of root development over a span of time. Towards the latter half of the 20th century with the advancement of science Bottomley *et al.* (1986) and Rogers and Bottomley (1987) described a method called Nuclear Magnetic Resonance which uses static and radio-frequency magnetic fields to detect the relative mobile protons of hydrogen in water molecules and the images of roots in soil are then analyzed to give data on various parameters of the root system. The methods mentioned above are used to determine the pattern of root development in fully or partially grown trees.

Eucalypts are very resilient and can adapt to a variety of situations and can often grow relatively well in below average soil conditions. Even though growing eucalypts from seeds are the easiest method of propagation, a highly viable alternative is vegetative propagation through cuttings. Rooting is induced in these cuttings by the presence of auxin and then they are transferred to plantations (Watt *et al.* 2003; de Assis *et al.* 2004). Ferriera *et al.* (2004) carried out a temporal analysis of the rooting curves of two different clones of *Eucalyptus* (Clone 1 – *E. grandis* x *E. urophylla*; Clone 2 -*E. grandis* x *E. saligna*). He determined the optimal time of permanence and stated that induction of rhizogenesis was clone dependant.

It is well known that auxin promotes root initiation (Chambers 2011). de Assis *et al.* (2004) tested the effects of different auxins on mini-cuttings of Eucalypts and determined that Indole-3-butyric acid (IBA) was the most successful in initiating rooting in cuttings. Recently investigations into combining IBA with other treatments (such as anti-ethylene treatments) have shown promising results in improving vegetative propagation of eucalypt hybrids (Kilkenny *et al.* 2012). Fogac¸ and Fett-Neto (2005) did a comparative analysis of the adventitious rooting of micro cuttings of *Eucalyptus saligna* (easy-to-root species) and *Eucalyptus globulus* (difficult-to-root species). Their experiments were carried out in presence of different types of auxins, light intensities, presence or absence of apical meristem, different concentrations of phenolic compounds and presence or absence of an ethylene action inhibitor. They evaluated different parameters like percent rooting, number of roots per rooted cutting, length of longest root and mean rooting time. The results showed that auxins of intermediate stability are more favorable to rooting, higher light intensities in the presence of exogenous auxins promote the rooting response and the absence of meristematic apex or externally supplied phenolics are not limiting for the rooting induced by exogenous auxins. Karthikeyan *et al.* (2011) did their research work on *Eucalyptus camaldulensis* due to its commercial importance in paper and pulp industries. At the time of vegetative propagation they used IBA for successful rooting of its stem cuttings. To reduce cost of IBA and as an alternative method they used a nitrogen fixing bacteria *Azotobacter chroococcum* in stem cuttings of *Eucalyptus camaldulensis*. They applied bacterial inoculums at the rate of 5 and 10 mL to the rooting substrate (vermiculite) during the installation of cuttings. Their results revealed that *A. chroococcum* produced high quantities of IAA for root initiation and *A. chroococcum* inoculated cuttings had a higher growth than IBA treated cuttings. Brondani *et al.* (2012) tried to assess the percentage of adventitious rooting under varying storage times in low temperature and at differing concentrations of IBA to determine the optimal time of application of hormones for rooting *Eucalyptus benthamii* mini-cuttings in a greenhouse. For their first experiment they stored the mini-cuttings at 4°C for 0 (immediate planting), 24, 48, 72, 96 and 120 h. Then they tried to evaluate the optimal time of permanence for mini-cuttings in a greenhouse. They treated the mini-cuttings with varying concentrations of IBA and performed destructive sampling every seven days to determine the histology of adventitious rooting. They proposed that *Eucalyptus benthamii* mini cuttings should be rooted immediately after the collection of the shoots. They also found that 2,000 mg/L IBA concentration induced greater speed and percentage of rooting and an interval of 35-42 days was indicated for permanence of mini-cuttings in greenhouse.

Gilvano Ebling Brondani (2012) determined the optimal time of permanence of vegetative propagaules for rooting inside a greenhouse using mini-cuttings of three clones of *E. benthamii* x *E. dunnii*(H12, H19 and H20). They determined the rooting percentage, the total length of the root system and rooting rate per mini-cutting at 0, 7, 14, 21, 28, 35, 42, 49 and 56 days and used logistic and exponential regression to mathematically model the speed of rhizogenesis.

While most researchers focused on specific aspects of rooting in Eucalypts, Nirvana Ramlal (2014) did a comprehensive work on producing roots in *E. dunii* by using various methods used in forestry. She compared and characterized the roots in order to understand the distinctions between them. She compared micropropagated plantlets and seedlings of the same height range showed that root architecture of main roots, main side roots, number of side root and shoot masses were all statistically similar and thereby stated that mini-cutting plantlets and seedlings of the same height range seemed similar in shoot:root ratios and root lengths and no direct comparisons could be drawn from the study due to the varying growth conditions of the samples before analysis, as well as restrictions on root growth by containers.

III. METHODS OF PROPAGATING EUCALYPTS

Even though growing Eucalypts from seeds is fairly easy, seeds of certain species like *E. elata*, *E. dives* require pre-treatment like cold stratification. With the advancement of propagation techniques, clonal hedges are field grown to provide vegetative material for production of mini-cuttings. Rooting is induced in these mini-cuttings mainly by auxin treatment and rooted mini-cuttings are transferred to the plantations (Watt *et al.*, 2003; de Assis *et al.*, 2004). This method of vegetative propagation has been successfully used for a number of eucalypt species on a commercial scale around the world (Herbert, 2000). There are different methods of propagating eucalypts though cuttings.

Coppice shoot cutting: Juvenile coppice shoots are considered to be the best material for mass propagation of eucalypts. Cuttings prepared from coppice shoots root in about 30-45 days. The only limitation to this method is that very mature trees coppice poorly and thus selection of the tree to be coppiced has to be done properly and with due consideration to its age and growth pattern.

Epicormic Shoot cutting: Juvenile epicormic shoots that are collected from the basal region of the tree are extremely easy to root and the method of rooting epicormic shoot cutting is similar to that of coppice shoot cuttings.

Semi Hardwood cutting: Non-leafy semi-hardwood cuttings of seedlings which are less than 1 year in age can be rooted using exogenous auxin treatment.

Micro cutting: The origin of this type of cutting was in Brazil and it was developed by observing that the rooting ability of stem cuttings decreases rapidly with ontogenetic aging. Juvenile plants, or plants rejuvenated *in vitro* are used as sources of vegetative propagules and the shoot apices are used as micro cuttings. Presence of shoot apices induces a taproot like system which results in a well develop overall plant.

Mini cutting: Both the mini and micro cutting techniques are very similar in concept and operational procedures and they differ mainly in the origin of the initial propagules. While micro cuttings are obtained from shoot apices originating from micro propagated plants, mini-cuttings come from axillary sprouts of plants cloned as stem-cuttings. The rooting ability of mini cuttings is much higher than that of the stem cuttings due to higher levels of juvenility and optimal nutritional content of the tissues.

IV. CONCLUSION

Eucalypts being a commercially important is highly valued in paper and pulp industries. Improving the rooting of difficult-to-root eucalypt species is a necessity which has to be overcome in order to make eucalypts commercially more valuable. The work that has been done related to rooting in eucalypts has been extensive and has met with a high degree of success. A detailed study of root architecture would go a long way in understanding root-soil interaction and help in improving the rooting capacity of plants and thereby increase the chances of propagation.

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