Is IBA an Effective Promoter of Root Formation on Cuttings of *Eucalyptus grandis*?

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Cuttings of a single clone of *Eucalyptus grandis* ex Hill. showed a positive rooting response to the presence of IBA applied as a liquid to the cutting base. The magnitude of the response varied with each of three identical trials conducted during winter, spring, and summer and it was not possible to define any optimal dose rate in the range 0 to 10,000 ppm IBA. A concentration of 2000 ppm was as equally effective as 4000, 6000, 8000, or 10,000 ppm. Root formation on cuttings dipped in IBA for 1 second was no different to that on cuttings dipped for 5 or 10 seconds. No advantage was achieved by allowing the base of treated cuttings to dry before the cuttings were inserted into the propagation mix.

INTRODUCTION

The use of auxins to promote adventitious root formation on cuttings is routine in many production nurseries. It is an easily applied treatment and is effective for many plant species.

Commercially important species of eucalypts are routinely propagated by cuttings in countries including Brazil, Portugal, and South Africa. All the descriptions of propagation techniques used in the nurseries refer to the use of IBA and also indicate that a range of IBA concentrations are used. Cuttings of *Eucalyptus camaldulensis* may be treated with 0.1% IBA (Marien, 1992) or 0.8% (Reuveni et al., 1990) and those of *E. globulus* with no IBA (Wilson, personal communication) or 0.8% (Hetherington and Orme, 1989). A similar range of concentrations has been used for *E. grandis*, for example Geary and Lutz (1985) reported use of 0.3% IBA and Wignall et al. (1991) used 0.8%.

That different nurseries have used different IBA treatments for the same eucalypt species suggests that cuttings may show a positive response to a broad range of IBA concentrations. It may be there is no one optimal IBA concentration and indeed it may also be possible that cuttings prepared without IBA treatment will root just as well as nontreated cuttings. Evidence to clarify these points is required as the auxin treatment adds material and time costs to production of the rooted cuttings.

In the study reported here we investigated a method of applying the IBA to the cutting. This was done as an attempt to clarify two points, firstly to look for time effective methods of applying the auxin and secondly to see if reproducible results could be obtained.

Liquid preparations of IBA are generally applied to each cutting as a quick dip of 5 to 10 sec. The trial investigated whether it was possible to achieve effective root promotion by using shorter insertion times. We also considered whether the cutting base must have dried before it is inserted into the propagation medium. To insert the cutting while still wet may mean some of the IBA solution is lost by absorption to the medium. But to wait for the cutting to dry means extra time is required and this adds to production costs.

We also considered the question of whether a single clone of *E. grandis* will consistently show the same rooting response to a given concentration of IBA. Cuttings of *E. grandis* were treated with IBA solutions in a range of concentrations. Three identical trials were conducted, one each in winter, spring, and summer.

MATERIALS AND METHODS

A single clone of *E. grandis* was used for all trials. Stock plants had been established from rooted cuttings either 2 or 3 years prior to the trials and grown in containers in a greenhouse with an average air temperature of 25C day and 15C night. They received natural radiation and photoperiod.

Cutting preparation was identical in all trials. Eight-week-old shoots were harvested from stockplants and trimmed to four leaf pairs. Leaves were removed from the two basal nodes.

The IBA solutions were made from K-IBA dissolved in ethanol. Unless stated otherwise, a preparation of 8000 ppm was used and the basal 1 cm of the stem was dipped into the solution for 1 sec.

After cuttings were given the specified treatments they were inserted into Kwik® pot trays. The trays contained a mixture of 1 peat, 1 perlite, and 1 sand (by volume). After cuttings insertion the trays were placed on a propagation bench with bottom heat and overhead misting.

For all trials, assessment of the cuttings took place 50 days after the cuttings were inserted. Cuttings were scored for the presence of roots and the number of roots per rooted cutting.

Raw data for percentage rooting was analyzed for variance using a logistic regression. Data for root mass and root number was analyzed for variance using an unbalanced mixed model treated with REML.

Experiment 1 - Trials 1 and 2. These two identical trials, conducted in October 1990 and January 1991, looked at adventitious root formation on cuttings after they were dipped into IBA for 1, 5, or 10 seconds. Pairs of cuttings were treated with IBA. The base of one cutting was immediately inserted into the medium and the other was allowed to dry before insertion. The cuttings were arranged in four randomized blocks. Each block contained 10 pairs of cuttings for each of the three immersion time treatments. Each pair represented a wet and dry insertion.

Experiment 2 - Trials 3, 4, and 5. This series of trials consisted of three identical investigations to find an optimal concentration of IBA to promote root formation on cuttings. The trials were conducted in August and October 1992 and January 1993. Treatments consisted of IBA concentrations of 0, 2000, 4000, 6000, 8000, and 10,000 ppm. The control treatment was ethanol. Cuttings were dipped into the solutions, removed, and to ensure each cutting absorbed the IBA, the stems were allowed to dry before the cuttings were inserted into trays. Cuttings

were placed into a randomized block design of six blocks. Each block contained four replicates of each of the six treatments.

RESULTS

The length of time for which the cuttings were held in the IBA solution had no significant effect on root formation (Table 1). For example in trial 1, cuttings given 1-, 5-, or 10-second treatments showed no difference in the number rooted or the number of roots per rooted cutting.

Table 1. The rooting response of *Eucalyptus grandis* cuttings dipped in an IBA solution for 1, 5, or 10 seconds.

Dip time (sec)	Rooting (%)		Root number/cutting	
	Trial 1	Trial 2	Trial 1	Trial 2
1	66	65	1.6	1.9
5	58	75	1.6	2.1
10	61	83	1.6	1.9
mean value	62	74	1.6	2.0

Allowing the IBA solution to dry on the base of the cutting before it was inserted into the propagation media had no consistent effect on root formation (Table 2). In trial 1, significantly more cuttings rooted if inserted with a dry base, but the number of roots per cutting did not differ from that of cuttings with a wet base. In trial 2 there was no significant difference in treatment effects on the percentage of cuttings to root or the number of roots per cutting.

Table 2. The rooting response of *Eucalyptus grandis* cuttings, treated with IBA and then inserted into the propagation medium with wet or dry stems.

Insertion treatment	Rooting (%)		Root number/cutting	
	Trial 1*	Trial 2	Trial 1	Trial 2
base wet	49	75	1.4	1.9
base dry	75	72	1.7	1.9
mean value	62	73	1.6	1.9

* Significant difference between treatments within the trial at a probability level of 0.05.

Interactions between the duration of the dip and the method of allowing the stem to dry after the dip, were tested and found to be nonsignificant.

Cuttings treated with different dose rates of IBA showed no consistent response in adventitious root formation (Table 3). In trial 3 there was no evidence of

significant treatment effects and although in trials 4 and 5 significant differences did occur, the pattern of difference was unclear. In trial 4 there was a suggestion of inhibition of rooting at the higher levels of IBA whereas in trial 5 all treatments with IBA rooted better than the control that had no IBA.

For both experiments, rooting response changed notably between trials. This variation between trials was often greater than that within a trial. For example, in experiment two, means for all treatments within a trial show that trial four cuttings rooted only half as frequently and had half as many roots as trial five cuttings (Table 3).

Table 3. The effect of variable IBA dose rates on root formation on cuttings of *Eucalyptus grandis*.

Treatment IBA ppm	Rooting (%)			Root number/cutting		
Trials	3	4*	5*	3	4	5
0	67	42	71	1.8	1.4	2.3
2,000	54	75	92	1.9	1.3	2.9
4,000	70	50	96	2.2	1.4	4.3
6,000	71	54	88	2.3	1.5	5.3
8,000	67	38	92	1.7	1.9	2.6
1,0000	75	29	99	2.6	2.0	3.3
mean value	67	48	90	2.1	1.6	3.5

* Significant differences between treatments within trials at a probability level of 0.05.

DISCUSSION

These experiments indicate that within the range of IBA solutions tested there was no evidence of strong root promotion or inhibition on *E. grandis* cuttings. All that can be concluded is that some IBA is probably better than none. It seems likely that a dose rate of 2000 ppm was just as effective as higher concentrations.

The results have also suggested that to apply liquid IBA preparations it is only necessary to dip the cuttings into the solution for sufficient time to wet the stem. A 1-second immersion is just as effective as a 5- or 10-second immersion. There remains the possibility that exposures longer than 10 seconds would allow greater uptake of IBA into stem tissues but such treatment does not seem necessary.

Despite the rigourous approach used in these experiments there were large variations in results between repeat trials. These variations are not consistent with seasonal effects and remain unexplained. However, it is clear that the use of IBA was not able to overcome the effects on rooting of any unknown factors. This is illustrated in trial 5 by the non-IBA-treated controls that rooted as well or better that any IBA-treated cuttings in trials 3 and 4.

The lack of repeatability in experiments of this nature has been previously pointed out by Loach (1988) in a review of the use of auxins as an aid to rooting of cuttings.

Our experiments confirm his conclusions and provide a caution to propagators who may consider adopting the results of non-repeated trials.

We also suggest that use of IBA on naturally poor rooting clones will not significantly improve adventitious root formation. Rather than spend time on lengthy trials to find optimal auxin rates it may be better to seek clones that naturally have a high rooting potential.

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