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Rooting and growth potential of Leucadendron laxum (proteaceae) using different rooting mediums and indoleacetic acid growth regulators

Laubscher, Charles Petrus

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ROOTING AND GROWTH POTENTIAL OF *LEUCADENDRON LAXUM* (PROTEACEAE) USING DIFFERENT ROOTING MEDIUMS AND INDOLE ACETIC ACID GROWTH REGULATORS

CP LAUBSCHER AND PA NDAKIDEMI

ABSTRACT

Leucadendron laxum (Proteaceae) is a South African plant species with a high commercial value as a flowering potted plant. Limited research information on the culture and propagation of this species is available in South Africa.The application of rooting hormone indole acetic acid (IAA) in various rooting mediums in *L. laxum* was tested. The treatments included: control, 500, 1000, 2000 and 4000 ppm, and four rooting mediums: a) bark / polystyrene; b) peat moss / polystyrene; c) bark / river sand / polystyrene; and d) perlite / river sand. A randomised block design with three replicates was used. Compared with other mediums, bark and polystyrene had the highest significant results in root and shoot growth, and the percentage that callused, rooted and survived. The IAA treatments at different concentrations had significant effects on rooting, callusing, shoot growth, root lengths and numbers of roots per cutting.

Keywords: Auxin; flower industry; flowering; potted plants; shoot growth.

1. INTRODUCTION

Leucadendron laxum is an endangered plant species of the Proteaceae family which naturally occurs on the Agulhas Plain in the southernmost tip of Africa (Hilton-Taylor, 1996). This species is also an important component of the indigenous export cut flower industry in the Western Cape, South Africa. Its attractive yellow-red flowers and especially the female cones are favoured in mixed bouquets and in the dried flower industry (Dodd & Bell, 1993:281-293; Coetzee & Littlejohn, 1994; Moody, 1995:111-112; Paterson-Jones, 2000; Berney, 2000). The natural growth habit of *L. laxum* has the potential for further commercial flowering pot plant production. No previous studies were found on the pot plant production of this species. A world-wide demand for new and interesting flowering potted plants (Barzilay et al., 1992:117-124) continues to raise a strong interest in the wide biodiversity potential of South African flora (Milandri et al., 2008:239-243). The *L. laxum* is one of the plant species with potential in the flower market. However, most members in this family are categorised as difficult-to-root plants and may require special auxin treatments and environmental conditions to facilitate their propagation (Hartmann et al., 2002:319). The vegetative propagation of this species is an important factor as faster rooting techniques are necessary for profitable commercial production of high quality products (Robyn & Littlejohn, 2002). Rooted cuttings have the added advantage that they will flower a year earlier than seed-grown plants (Reinten et al., 2002). Appropriate vegetative propagation techniques for *L. laxum* would increase the production in controlled greenhouse conditions to supply the demand. The use of rooting hormones such as IAA would prove useful in speeding up the rooting of difficult-to-root plants such as *L. laxum*. New and more effective auxin formulations are required to increase success in rooting percentages of some difficult-to-root Proteaceae (Hartmann et al., 2002:294-296).

Auxins have an important role in speeding up uniform rooting and increasing rooting percentages during vegetative propagation (Hartmann et al., 2002; Fogaça & Fett-Neto, 2005:1-10). While some Proteaceae cuttings are difficult to root, other species have shown positive responses to auxin treatments (Hartmann et al., 2002:319). IAA that occurs naturally in the plants may not be adequate in enhancing auxin functions in plants (Hartmann et al., 2002:295). Therefore testing of different concentrations of IAA on *L. laxum*, will identify the treatment that produces the most desirable rooting results. No other studies were found which previously described the use of IAA auxin on the rooting of *L. laxum*.

Research into combinations of different rooting mediums is essential in ensuring faster and better quality root formation. The possibility of improved results might be possible under different conditions or with various auxin treatments. Good quality shredded milled pine bark is recommended for pH control (Owings, 1996:699) or can be substituted with a coarse-grade peat moss to enhance further water-holding capacity of the growing medium (Hartmann et al., 2002). Polystyrene improves aeration, whereas washed river sand provides coarseness and drainage (Hartmann et al., 2002).

The aim of this study was therefore to determine whether *L. laxum* responded favourably to different concentrations of IAA rooting hormones in various rooting mediums under a controlled greenhouse environment with bottom heating to ensure faster and more efficient rooting success in flowering pot-plant production.

2. METHODOLOGY

2.1 Experimental

The study was conducted at the nursery of the Cape Peninsula University of Technology in Cape Town, South Africa, in 2006. An environmentally controlled greenhouse covered in clear polycarbonate and fitted with a shade screen (40%) was used. Temperatures and humidity were monitored on a weekly basis, with midday temperatures fluctuating between 22 and 27C and relative humidity between 39 and 86%. The irrigation timer was set at 15 secs on and 20 mins off. Cutting material of L. laxum was collected from selected plant populations in their natural habitat on the Agulhas Plain and kept dry and cool during overnight transportation.

2.2 Setup and design

For this study, four growth mediums: a) bark / polystyrene; b) peat moss / polystyrene; c) bark / river sand / polystyrene; and d) perlite / river sand were used. Four concentrations of IAA (0, 500, 1000, 2000 and 4000) were set up in a randomised complete block design involving three replications and four growth mediums. The IAA solution was prepared as described by Brown and Duncan (2006:14). The IAA powder was dissolved in 50% ethyl alcohol and made up in the appropriate concentration by adding distilled water. The basal five mm of cuttings were dipped for five seconds in the IAA rooting hormone (Reinten et al., 2002; Hartmann et al., 2002:371) and cuttings were planted into foam plug trays containing different growth mediums. The experiment was conducted in a controlled greenhouse with heated beds (20 25 ºC) with mist bed conditions (Brown & Duncan, 2006:14). For this study, terminal cuttings measuring approximately 150 mm in length were used. All cuttings were taken during dry weather from turgid semi-hardwood stems in the month of November after shoot elongation (SAFEC, 2002). Cuttings were rinsed in Benlate fungicide (10g/l) before planting and sprayed weekly with a Captan (2 g/l) solution after planting to prevent the infection from disease-causing organisms (Reinten et al., 2002; SAFEC, 2002). Wilted and infected cuttings were removed over the rooting period.

2.3 Data collection and analysis

Cuttings were evaluated on a weekly basis to monitor results of the hormone treatment and the influence of the rooting medium on the rooting progress of *L. laxum*. The parameters measured were: number of cuttings callused, number of cuttings rooted, and the survival rate of cuttings. Shoot growth (mm), length of roots (mm) and number of roots per cutting were measured from the cutting stage to new growth stage after eight weeks. Data on the number of cuttings that formed calluses, the number of cuttings that rooted and the cuttings that survived were converted into percentages prior to analysis of variances. Data analysis was performed in two different ways. Firstly, descriptive analytical techniques were employed, and then factorial analysis, including IAA concentrations and growth mediums was used. These computations were done with the software program STATISTICA. The Fisher least significance difference (L.S.D.) was used to compare treatment means at $P < 0.05$ level of significance (Steel & Torrie, 1980).

3. RESULTS AND DISCUSSION

3.1 The effect of different growth mediums on rooting responses in *L. laxum*

The different rooting and growth parameters of *L. laxum* were significantly influenced by the four growth mediums used in the study over the period of eight weeks (Table 1). The bark / polystyrene medium was most significantly superior to other growth mediums. This was followed by 1) peat / polystyrene and 2) bark / sand / polystyrene. The results recorded across these two mediums were not statistically different from each other (Table 1). The perlite / sand medium was less successful in producing significant results. The lower response in the perlite / river sand medium could be attributed to the possibility of a coarser aggregate with faster draining of water around the root zone area. The percentage increases in rooting characteristics of *L. laxum* in comparison with the poorly performing medium (perlite / sand) and the best medium (bark / polystyrene) ranged from 4 60; 0 40 and 27 88 for callusing, rooting and survival rate respectively (Table 1).

Table 1. Effect of different growth mediums on percentage callus formed, cuttings that rooted, survival rates of cuttings, shoot growth, root length and the number of roots per cutting of *Leucadendron laxum* supplied with IAA

Main treatment	Percentage measured						Growth measured (mm)					
	% Callused		% Rooted		% Survival		Shoot growth		Root length		Number of roots/cutting	
Rooting medium:												
Bark/ Polystrene	**60**	**±7.2a**	**40**	**±8.8a**	**88**	**±4.4a**	**3.9**	**±1.0a**	1.0	±0.4a	**1.6**	**±0.5a**
Peat/ Polystrene	**35**	**±6.1b**	**10**	**±4.7b**	**66**	**±8.7a**	**1.1**	**±0.3b**	4.1	±2.5a	**0.7**	**±0.3b**
Bark/Sand /Polystrene	**35**	**±6.1b**	**10**	**±4.7b**	**65**	**±8.5a**	**1.1**	**±0.4b**	4.1	±2.5a	**0.7**	**±0.3b**
Perlite / Sand	**4.0**	**±4.0c**	**0.0**	**±0.0c**	**27**	**±9.4b**	**0.0**	**±0.0c**	0.0	±0.0a	**0.0**	**±0.0c**
F Statistic	**12.4*****		**7.9*****		**6.53*****		**0.001****		0.27 ns		**0.008****	

Notes: Values presented are means ± SE. **, *** indicate statistical significant at P $\leqslant$ 0.01 and 0.001 respectively. ns indicates not significant. Means followed by the same letter in the same column are not significantly different from each other at P $\leqslant$ 0.05.

With regard to growth (shoot growth, root length and number of roots per cutting) all parameters except root length were significantly influenced by growth mediums. The bark / polystyrene medium was significantly superior to all other mediums (Table 1). These were followed by 1) peat / polystyrene and 2) bark / sand / polystyrene which showed non-significant results among them (Table 1). In the perlite / sand medium, there was no growth recorded at all (Table 1). The shoot growth and number of roots per cutting increased from 0 - 3.9 mm and 0 - 1.6 respectively when 1) perlite / sand and 2) bark / polystyrene medium were compared.

A number of studies have shown that growth mediums may have profound influences on the rooting of cuttings in different plant species (Leakey et al., 1990:247-257; Ofori et al., 1996:39-48). The improved callusing, rooting, percentage survival rate, shoot growth and number of roots per cutting in bark / polystyrene medium compared with other mediums indicated that the medium was highly advantageous in the propagation of *L. laxum*. The overall success in the bark / polystyrene medium implied that this medium was highly suitable for the propagation of *L. laxum* owing to the moisture-holding and aerated properties, and hence suitable for the propagation of other Proteaceae species. Our results suggested that the appropriate medium with good air : water ratio such as the bark / polystyrene medium was a key to successful rooting (Leakey et al., 1990:247-257). Adequate moisture and aeration in the growth mediums were essential in supplying water and enough oxygen for respiration in the cuttings. Similar success in a bark / polystyrene medium has been reported in other studies involving other Proteaceae species (Brown & Duncan, 2006:14; Reinten et al., 2002).

3.2 Effect of different concentrations of IAA on rooting and shoot growth of L. laxum cuttings

Different rates of IAA applications had some significant effects on callus formation in *L. laxum*. The maximum percentage of callusing (45%) was recorded in cuttings supplied with IAA at 500 ppm (Fig. 1). However, callusing was significantly inhibited at the highest concentration (4000 ppm) of IAA treatment (Fig. 1). With regard to rooting percentages, results showed a progressive increase in rooting by increasing IAA supply rates from 1000 4000 ppm (Fig. 1). The highest rooting (21%) was recorded in the cuttings that received the 4000 ppm treatment (Fig. 1). The IAA treatments did not significantly affect the survival rate of the cuttings (Fig. 1).

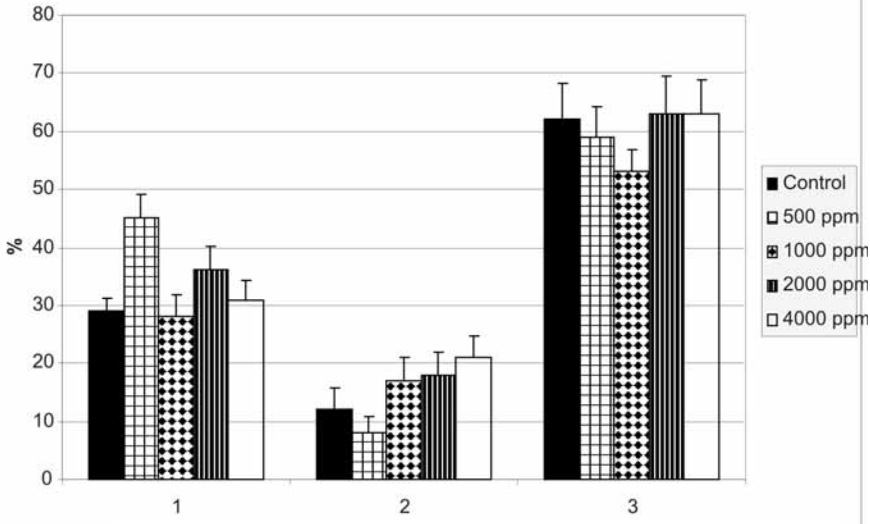

Fig. 1. Rooting Parameters: 1 = % Callused: 2 = % Rooted 3 = % Survived
Bars followed by dissimilar letter(s) are signaficantly different P0 05

Results on different growth parameters (shoot growth, root length and number of roots per cutting) recorded after eight weeks showed a significant influence of pre-treating *L. laxum* cuttings with IAA auxin (Fig. 2). Supplying IAA at 2000 and 4000 ppm gave the best growth results, with values ranging from 1.8 and 1.9 mm in shoot growth and 1.0 1.2 in root numbers respectively (Fig. 2). Results for root length were not consistent (Fig. 2). In our study, the overall best rooting and growth occurred at higher IAA treatments (Figs. 1 2).

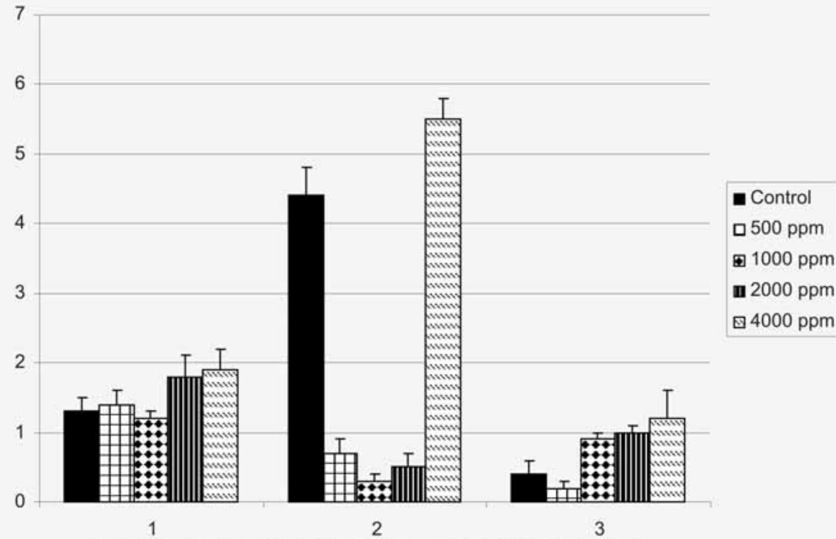

Fig. 2: Growth Parameters: 1= Shoot growth (mm); 2 = Root length (mm); 3 = Number of roots per cutting. Bars followed by dissimilar letters are significantly different at P=0.05

Auxins such as IAA are growth-promoting substances that are supplied exogenously to the cuttings to stimulate the meristematic cell division and promote rooting in cuttings (Rout, 2006:111-117). Results from our study showed that the exogenous supply of auxin (IAA) at different rates significantly enhanced different rooting and growth parameters of *L. laxum* (Figs. 1 & 2). Our results are in accordance with other studies in which IAA stimulated rooting characteristics and growth in several plant species (Liu et al., 1996:247-257 & 1998:113-118; De Klerk et al., 1997:188-189). In most cases, higher concentrations of IAA produced better results (Figs. 1 2), thus suggesting that this hormone is limited in the plant tissues and hence its application in stimulating rooting was essential in *L. laxum* cuttings. Several studies have reported correlations between higher IAA concentrations in plant tissues and rooting in different plant species (Hartmann et al., 2002:295). From our study it was important to establish the optimum level(s) of IAA necessary to stimulate root development in *L. laxum*. The environmentally controlled greenhouse with bottom heat and misting was conducive in enhancing rooting, growth and survival of cuttings. These growth conditions are in agreement with studies in propagating other Proteaceae (Brown & Duncan, 2006:14; Reinten et al., 2002).

4. CONCLUSIONS

The results from this study showed that the bark / polystyrene medium was the most significant medium that contributed sufficiently to the root development, survival rate and root length of cuttings. The optimum IAA levels that stimulated rooting in *L. laxum* were established. Generally, when compared with the control treatment, the IAA hormone treatment had significant effects on rooting success of the *L. laxum* cuttings. The successful production of quality cuttings of *L. laxum* for the indigenous cut flower industry could largely be achieved by choosing the appropriate growth medium supported with the correct concentration of growth hormone.

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