teresting alternatives which have been frustratingly slow growers in our nursery to date.

Perhaps the slow growth rate from cuttings and nut grafts is due to physiologically aged plant material. The plants produced from cuttings and nut grafts look excellent but their slow growth rate make them uneconomical as advanced nursery trees.

I believe punch budding to have application on other plants especially those which tend to have brittle, non-pliable bark.

EFFECT OF SUPPLEMENTARY LIGHT AND AUXIN APPLICATIONS ON ROOTING LEAFY CUTTINGS OF CERTAIN AUSTRALIAN SPECIES

R.K. ELLYARD

Canberra Botanic Gardens
Canberra, A.C.T.

Abstract. In studies undertaken with five Australian native species supplementary light was found to produce a small but statistically significant increase in the percentage of cuttings which rooted and in the number of roots per cutting. In a study using 9 species a concentrated-dip auxin application of IBA + NAA was found to be far superior to a talc dust containing only IBA in increasing both the percentage of cuttings which rooted and the roots produced per cutting.

EFFECT OF SUPPLEMENTARY LIGHT

In all types of plant growth light is of major importance since it is the source of energy in photosynthesis. In rooting leafy cuttings, the products of photosynthesis are important for root initiation and growth. Therefore, during rooting, light intensity and duration must be sufficient to ensure that carbohydrate production is in excess to that required for respiration.

There is some evidence that the photoperiod under which stock plants are grown may exert an influence on the rooting of cuttings taken from them. This may be related to carboyhydrate accumulation since the best rooting has been observed under photoperiods which favor carbohydrate accumulation. There are, however, examples where stock plants held under short photoperiods have produced the best rooted cuttings (9).

The photoperiod under which the cuttings are rooted may also effect root initiation. A number of workers have suggested that long days result in earlier and better rooting of many species (1,2,6,8) but delay rooting in others (4).

Little is known on the effect of increased daylength on the rooting of leafy cuttings of Australian species. Work undertaken at the Canberra Botanic Gardens (5) has shown that in the case of three species studied, the extension of the daylength to 22 hours increased the percentage rooting, the number of roots per cutting, and decreased time taken for cuttings to root.

In February an experiment was set up to extend the work of McIntyre to five more species and to also study the interaction of light and rooting hormone (auxins).

MATERIALS AND METHODS

Two areas of bench, each measuring 1.5 m × 0.8 m, were set aside in the propagation glasshouse. Each area was heated by bottom heat to maintain a temperature of 25°C ± 1°C in the region of the basal ends of the cuttings. Both areas were under mist. One area received supplementary light from eight fluorescent tubes (40 watts, 1.4 m long) set 0.8 m above the bench. These lights were switched on for 22 hours per day.

Semihard material of each species was collected and 400 tip cuttings of each species prepared. Cuttings were placed to a depth of 50 mm in 100 mm square plastic pots containing a medium of equal parts of sand, perlite and peat moss. Twenty cuttings were placed in each pot. For each species 200 cuttings (10 × 20) were pretreated with Seredex 2 (3000 ppm IBA in talc). The plastic pots containing the cuttings were divided randomly into two equal groups, each containing 5 × 20 untreated cuttings (control) and 5 × 20 Seredex 2 treated cuttings. One group was placed on the control bench and the other on the bench receiving supplementary light. The pots on each bench were rerandomized three times per week.

All the cuttings of a species were harvested one week after roots were first observed out of the bottom of any pot. The cuttings were carefully removed from the pots and the medium removed from the roots by careful washing under water. The roots per cutting and the percentage rooted were recorded.

RESULTS

Data on the effects of light and auxin on the percentage of cuttings rooted is presented in Table 1. Those cuttings receiving supplementary light showed a slightly greater rooting percentage for each of the five species studied. Statistical analysis showed the difference to be significant at a 1% level.

Each treatment contained 100 cuttings. Cuttings for the five species were harvest at the following times after placement on the propagation bench. *Westringia fruiticosa*: 5 weeks; *Acacia howittii*: 8 weeks; *Eriostemon myoporoides*: 8 weeks; *Kunzea*

Table 1. Effect of supplementary light and Seredex 2 treatment on the number of rooted cuttings in 100 cutting samples from five Australian species.

		Westringia fruticosa	*Acacia howittii*	*Eriostemon myoporoides*	*Kunzea ambigua*	*Grevillea laurifolia*	*Total*	
Supplementary Light	Control	91	21	64	29	10	215	
	Hormone	89	33	58	40	13	233	
	Totals	180	54	122	69	23	448	
No Supplementary Light	Control	80	23	52	23	9	187	[1]402
	Hormone	81	27	50	30	6	194	[2]427
	Totals	161	50	102	53	15	381	

[1] Total for control cuttings.
[2] Total for auxin treated cuttings.

ambigua: 6 weeks; *Grevillea laurifolia*: 10 weeks.

Auxin treatment, however, was without effect on the rooting percentage. Statistical analysis indicated that there was no significant difference between the percentages obtained for auxin-treated and control cuttings.

A similar pattern was obtained when data on the roots per cutting was analyzed. Once again, no statistically significant effect of auxin treatment was observed. Supplementary lighting was found to produce a small, but statistically significant, increase in the roots per cutting.

EFFECT OF AUXIN APPLICATION

The ineffectiveness of Seredex 2 treatment to increase either the percentage rooting or roots per cutting was unexpected, and suggests that this method of auxin application was ineffective in getting auxin into the cutting. In recent work undertaken at the Botanic Gardens a comparison was made of the effect of method of application of auxins on rooting cuttings of several species.

MATERIALS AND METHODS

Nine species were studied. Cuttings were taken in May and struck under conditions similar to those outlined earlier in this paper. For each species, a third of the cuttings (50) were treated with Seredex 2 and a third with an IBA/NAA mixture applied as a concentrated dip. In this latter method the basal tip (5 mm) of the cutting was dipped into the concentrated dip for 5 seconds, removed and excess liquid allowed to evaporate (1 to 2 minutes) before cuttings were placed in the cutting medium. The remaining third were left untreated as a control.

Preparation of Concentrated Dip Solution. 1 gram indolyl 3 butyric acid (IBA and 1 gram naphthylacetic acid (NAA) were dissolved together in 125 ml of absolute alcohol (ethanol). This solution was diluted with 125 ml of distilled water to produce a stock solution containing 4000 ppm IBA and 4000 ppm NAA in 50% alcohol.

To produce a concentrated dip solution containing IBA/NAA at 1000 ppm/1000 ppm, 50 ml of the above stock solution was diluted with 150 ml of 50% alcohol (75 ml alcohol and 75 ml water). Dilution of 50 ml of this IBA 1000 ppm/NAA 1000 ppm with 50 ml of 50% alcohol produced an IBA 500 ppm/NAA 500 ppm concentrated dip. All solutions were stored in tightly sealed brown glass bottles below a temperature of 3-5°C. Solutions were allowed to return to room temperature before use.

RESULTS

Data for seven of the species studied is presented in Table 2. With the partial exception of *Calothamnus validus*, all cuttings at time of harvest were green and healthy in appearance. Five species, *Boronia heterophylla*, *Calothamnus validus*, *Callistemon viminalis*, *Prostanthera ovalifolia* and *Phebalium rotundifolium* showed a significantly higher percentage rooting for the concentrated dip treated cuttings than with either the talc dust (Seredex 2) treated or control cuttings. This was most marked in the case of *Prostanthera ovalifolia*. Three of these five species, *Prostanthera ovalifolia*, *Phebalium rotundifolium* and *Callistemon viminalis*, also showed a significantly higher number of roots per cutting following concentrated dip treatment.

For *Boronia heterophylla*, no difference was observed between the concentrated dip and talc dust treated cuttings as to the roots per cutting. A difference was observed, however, in the amount of callus and the position of the roots. The talc dust treatment produced a bulb of callus on the basal tip. Roots were confined to this area. The concentrated dip treatment, by contrast, produced callus extending up to 2.5 cm back from the basal tip. Root formation occurred in the extended callus region producing a better root system.

Malaleuca pulchella and *Correa pulchella* showed a high percentage rooting for all three treatments. For both species, however, there were twice as many roots per cutting in the concentrated dip treatment than in the other two treatments. In the case of *Correa pulchella* a difference was also observed in the position of the roots. For both talc treated and control cuttings roots were confined to the basal tip while the concen-

Table 2. Effect of rooting hormone on the percentage rooting (%R) and roots per cutting (R/C) of seven Australian species.[1]

	Boronia heterophylla		*Calothamnus validus*		*Callistemon viminalis*		*Correa pulchella*		*Melaleuca pulchella*		*Prostanthera ovalifolia*		*Phebalium rotundifolium*	
TREATMENT	**%R**	**R/C**	**%R**	**R/C**	**%R**	**R/C**	**%R**	**R/C**	**%R**	**R/C**	**%R**	**R/C**	**%R**	**R/C**
Control	34	1.4	0	—	14	2.0	97	8	90	2.8	32	2.9	22	1.9
Seredex 2	52	1.9	6	1.6	30	2.3	87	10	96	2.8	20	3.0	16	2.0
1000 ppm/ 1000 ppm dip[2]	70	2.1	30	1.5	52	4.9	100	19	96	5.6	100	15	64	3.0

[1] Each treatment contained 50 cuttings. All cuttings were harvested after six weeks.
[2] 1000/1000 ppm = 1000 ppm IBA: 1000 ppm NAA in 50% alcohol.

trated dip treatment produced callus and roots extending 2 cm back from the basal tip.

The results obtained with two other species, *Persoonia chamaepitys* and *Grevillea* × *gaudichaudi*, are presented in Table 3. In this study, two concentrations of IBA/NAA, applied as a concentrated dip, were compared with Seredex 2.

For *Persoonia chamaepitys*, IBA/NAA at 500 ppm/500 ppm was the most effective treatment in initiating roots. Both concentrated dip treatments resulted in the blackening and death of cuttings. This was much more prevalent in the case of the 1000 ppm/1000 ppm treatment.

The two *Grevillea* × *gaudichaudi* collections differed in their response to the concentrated dip formulations. For the first collection the 1000 ppm/1000 ppm concentrated dip produced the highest percentage rooting while the 500 ppm/500 ppm treatment was the more effective treatment in the second collection. In the latter case the 1000 ppm/1000 ppm treatment resulted in either the rooting or death of a cutting; no unrooted healthy cuttings were observed.

Table 3. Effect of method of application of rooting hormone on the percentage rooting (%) and roots per cutting (R/C) of two species.

	Persoonia chamaepitys		*Grevillea* × *gaudichaudi* Collection 1.		*Grevillea* × *gaudichaudi* Collection 2.	
TREATMENT	**%**	**R/C**	**%**	**R/C**	**%**	**R/C**
Seredex 2	0	—	13	1.3	38	1.9
500/500 ppm dip	52	—	25	1.5	76	4.1
1000/1000 ppm dip	14	—	70	2.1	22	4.0

DISCUSSION

Although considerable research has been undertaken into the effect of supplementary light on the rooting of cuttings, no clear picture has emerged. The role of light would appear complex. In this present work a beneficial effect for supplementary light has been demonstrated. The small size of this effect, however, may not justify the expense associated with installation and running cost of a light system.

A more profitable area for development might be in the area of exogenous auxin application. Talc dust formulations of auxin have generally been more widely used in the rooting of cuttings than have concentrated dip formulations, possibly because of ready commercial availability and their ease of application.

The work presented here has shown the talc dust formulation used, Seredex 2, was without effect. Its use did not increase percentage rooting or roots per cutting over the levels obtained for the controls.

The results presented in Tables 2 and 3 clearly show the superiority of concentrated dips of IBA + NAA over the talc dust application of IBA alone, a result in agreement with those of Heung *et al* (3) and Whalley (11).

The effectiveness of the concentrated dip treatment is undoubtedly related to a more efficient uptake of auxin by the cuttings. Its use, however, is not without problems; for example, the possibility of auxin burn if too high an auxin concentration is used. As Wain (10) has pointed out, the auxin concentration which is most active in rooting is often close to the toxic concentration.

Some horticulturists, in selecting the concentration of hormone to use, have applied the rule: the more tender the cutting material the weaker the hormone preparation should be. The results obtained in this work would not appear to support this view but instead support the findings of Roller (7); that a soft tender cutting can withstand hormone at a strength which would be fatal to a hardwood cutting. The two species which showed considerable hormone burn when treated with the 1000 ppm/1000 ppm concentrated dip were *Persoonia chamaepitys* and the second *Grevillea* ×*gaudichaudi* collection which had the hardest cutting material. The first *Grevillea* × *gaudichaudi* material was softer than the second. Some burn was also observed with *Calothamnus validus* which had the hardest material of the species listed in Table 2. Thus the problem of auxin burn may be reduced by using softer cutting material. Whalley (11) has also reported success in the elimination of auxin burn by the incorporation of 2,4,5 — trichlorophenoxypropionic acid

(0.1 ppm) into the concentrated dip. Experimental work is planned to investigate both these possibilities.

LITERATURE CITED

1. Carpenter, W.J.: G.R. Beck and G.A. Anderson 1973. High intensity supplementary lighting during rooting of herbaceous cuttings. *HortScience* 84(4)338.
2. Downs, R.J. 1966: Light and the growth of hollies. *Hort. Abstr.* 37, 1461.
3. Heung, Shi-luh, Rosa and J.J. McGuire 1973. Effect of formulation on uptake of 3-indoleacetic acid in cuttings. *Proc. Int. Plant Prop. Soc.* 23, 296.
4. Kamp, J.R. and E. Van Drunen 1958. Factors affecting propagation of *Taxus cuspidata capita*. *Flor. Exch.* 131, 28.
5. McIntyre, D.K. 1969. The response of cutting from eight different species of Australian native shrubs to different day lengths. *Canberra Botanic Gardens Reports* 69/10 (Unpublished)
6. Piringer, A.A. 1961. Photoperiod, supplementary light and the rooting of cuttings. *Proc. Int. Plant Prop. Soc.* 11, 261.
7. Roller, J.B. 1971. Rooting Juniper softwood cuttings under mist. *Proc. Int. Plant Prop. Soc.* 21, 340.
8. Snyder, W.E. 1955. Effects of photoperiod on cuttings of *Taxus cuspidata* while in the propagation bench and during the first growing season. *Proc. Amer. Soc. Hort. Sci.* 66, 397.
9. Steponkus, P.L. and L. Hogan. 1967. Some effects of photoperiod on the rooting of *Abelia grandiflora*. *Proc. Amer. Soc. Hort. Sci.* 91, 706.
10. Wain, R.L. 1974. Plant growth substances. *Proc. Int. Plant Prop. Soc.* 24, 138.
11. Whalley, D.N. 1969. Effect of growth regulators on rooting of gooseberry cuttings. *Comm. Gr.* 3811, 83.