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**Seed Germination Trials on Eleven
Eucalyptus Species**



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SEED GERMINATION TRIALS ON ELEVEN EUCALYPTUS SPECIES

SUMMARY

Germination trials were conducted on eleven Eucalyptus species to determine if pretreatments improved germination. The three pretreatments tested were soaking in water for 48 hours, soaking in 1% KNO₃ for 48 hours and scarification. All were exposed to light. The final germination values recorded for Eucalyptus accedens, W.V.Fitzg. E. calophylla R.Br. and E. marginata Donn ex Sm. were below 66% for the control treatments, suggesting these are dormant species. E. maculata Hook. and E. wandoo Blakely were the only species which showed a significant improvement in germination as a result of pretreatment.

The seed mix of some species contained a large proportion of chaff (i.e. unfertilised ovules). For five species the chaff could be removed by passing the seed mix through a sieve with a particular screen size. The remaining species require manual sorting.

INTRODUCTION

Many viable seeds do not germinate when placed under conditions which are normally regarded as favourable to germination. Dormancy can be due to internal properties of the seed such as the level of growth inhibitors relative to growth promoters, or to the physical structure of the seed coat (Mayer & Poljakoff-Mayber 1975; Mott & Groves 1981). It can also be due to external factors, for example, temperature, light or moisture conditions. Under natural conditions dormancy can be broken by time, temperature changes, leaching, decay, light, or other processes.

The germination of Eucalyptus seed is known to be influenced by light, temperature and moisture (Clifford 1953; Pryor 1954; Grose & Zimmer 1957, 1958; Grose 1965; Zohar, Waisel & Karschon 1975; Edgar 1977; Davidson & Reid 1980). Other authors have used such pretreatments as soaking in water or selected chemicals and scarification to break dormancy (Boden 1957; Bachelard 1967; Banks 1968). In this study germination tests were performed on eleven Eucalyptus species commonly used for rehabilitating bauxite minesites. Eight of these species are naturally restricted to Western Australia. Nursery germination rates for some of these species have been poor.

Published literature has concentrated on species native to the eastern states of Australia. There is little or no literature available on most species used in bauxite minesite rehabilitation. The objective of this study was to determine if some commonly used species were dormant and if so, to assess whether pretreatments could break dormancy. The pretreatments were also applied to non-dormant species to see if they improved germination over that of the control material.

METHOD

The eucalypt seed was purchased in October 1979 and was kept in cool, dry and semi-dark conditions until December 1980, when the germination trials commenced. The eleven species tested are listed in Table 1. The age of the seed was unknown. A sample of seed was manually removed from the seed and chaff mixture based on the seed identification technique of Edmiston & Ryan (1977). This involved squashing particles under a microscope (X10 magnification) and those particles that contained oil were regarded as seed. Once this test was conducted, it was possible to visually determine which particles were seed because of their size and/or colour.

The following four treatments were tested, although only three were applied to any one species (Table 1):

1. seeds not treated (control)
2. seeds soaked in water for 48 hours
3. seeds soaked in 1% KNO₃ solution for 48 hours
4. seeds scarified. Scarification of the larger seeds was done by making an incision with a needle probe. Smaller seeds were abraded with fine sandpaper.

A batch of approximately 150 seeds was used for each treatment. The seeds were placed in petri dishes (≈ 50 per dish) containing moistened filter paper, and kept at approximately 25°C. However, situations did arise where the temperature varied above and below this value. All pretreatments and the controls were exposed to a mixture of natural and fluorescent light (≈ 12 h photoperiod). Distilled water was added to the petri dishes as required. No fungicide was used. Seeds with emerged radicles were regarded as germinated and removed. The germination counts were made daily for 21 days. A chi-square test ($\alpha = 0.05$) was used to compare all pretreatments and the control. Individual 2 x 2 contingency tables were analysed by chi-square tests to determine the optimum treatment(s). The significance level was adjusted according to the formula:

$$\alpha^1 = \frac{\alpha}{2 \text{ (total no of comparisons)}}$$

because the individual 2 x 2 tables are non-independent (Everitt, 1976).

Many of the Eucalyptus species tested contained large amounts of chaff in the seed mix. Manual sorting of large volumes takes excessive time. As an alternative sorting technique, the seed and chaff mixes were passed through sieves with different screen sizes. If the screen retained all the seed but no chaff, then this was considered a successful sorting technique and the screen size was noted.

RESULTS

The germination percentages for each treatment are presented in Table 1, along with the results of the chi-square test. Of the eleven species tested only Eucalyptus accedens, E. calophylla and E. marginata appear to be dormant i.e. germination of the controls was less than 66% at 21 days (Banks 1968). However, none of the pretreatments tested broke their dormancy.

The recommended pre-treatment, taken as the treatment which resulted in the highest absolute percentage germination, is presented in Table 2. For nine species no single treatment was optimal. Soaking in water is the recommended pretreatment for six species.

Sieving the seed and chaff mixture proved to be a rapid sorting technique for five species (Table 3). In the remaining species the seed and chaff were of similar sizes and therefore could not readily be separated.

DISCUSSION

The germination tests suggest that Eucalyptus accedens, E. calophylla and E. marginata are dormant (Table 1) (Banks 1968). However, E. calophylla has a very large seed (over 5 mm long) and this may prevent sufficient seed surface contact with the moistened filter paper. A more accurate germination test would be to place the seeds in cotton wool or a layer of soil, to allow all of the seed to be in contact with moisture.

Grose (1965) and Davidson & Reid (1980) have reported differences in the germination characteristics of species in various Eucalyptus subgenera. Species belonging to the subgenus Symphomyrtus generally germinate at a faster rate than the Monocalyptus species. However, after stratification (i.e. storing the seed at 6.5°C, under moist conditions, for 30 days) there is no difference. E. marginata belongs to the subgenus Monocalyptus and was observed to be still germinating after 21 days. Perhaps stratification will overcome this species' dormancy, although this pretreatment is usually associated with alpine species.

Monocalyptus species have also been found to have a lower level of seed viability (Davidson & Reid 1980). Although the chaff was removed from the seed mix, no viability tests were conducted on the ungerminated seeds at the completion of the experiment. The presence of non-viable seeds may be the cause for low germination values in E. marginata and the other two dormant species. High germination levels were, however, recorded for E. patens Benth. which is also a member of the Monocalyptus subgenus. The reason for this dissimilarity is unknown.

According to Grose & Zimmer (1957), eucalypts may be grouped with respect to their germination requirements into: species requiring light, species requiring darkness, species requiring a combination of light and darkness, and species indifferent to light and darkness. So, although light can act as a dormancy breaking agent in some species, it can also inhibit germination in others (Clifford 1953; Grose 1965; Mayer & Poljakoff-Mayber 1975; Zohar et al. 1975). The presence of light may,

therefore, be inhibiting germination in E. accedens, E. calophylla or E. marginata. Both Grose & Zimmer (1957) and Clifford (1953) have found that E. maculata is indifferent to light and darkness, while the light requirements of E. camaldulensis Dehn. decrease as the temperature conditions approach optimum for germination (Grose & Zimmer 1958).

The soaking in water pretreatment gave a significant increase in germination for E. maculata and E. wandoo (Table 1). Boden (1957) has also observed similar increases for E. pauciflora Sieb. ex Spreng. These increases suggest there is a naturally occurring inhibitor in the seed which is removed by soaking (Justice 1972). Soaking in water gave the highest germination percentage for four other species tested in this study. However, one or more treatments gave statistically similar results (Table 1). This could mean an inhibitor is present. If this is so, then the moisture of the filter paper is sufficient to remove the inhibitor. Soaking in KNO_3 may also remove the inhibitor, and if so one might expect the water and KNO_3 treatments to produce the same results.

Soaking in 1% KNO_3 and scarification did not cause significant increases in germination in this study (Table 1). However, potassium nitrate has been recorded to stimulate germination of some dormant species (Boden 1957; Mayer & Poljakoff-Mayber 1975) and scarification improved the germination of five eucalypt species tested by Banks (1968). Scarification was actually detrimental to E. marginata, probably due to embryo damage.

Higher percentage germination values can be obtained for E. camaldulensis and E. maculata by incubating the seed at their optimum temperature (Grose 1965). These optimum temperatures are $35-38^\circ\text{C}$ and 27°C , respectively. Also four weeks stratification at 4°C will improve their germination percentage.

An important part of the experiment was the sorting of seed from chaff. Lack of sorting could be the reason for the low percentage germinations previously observed for some species. By using the sieving technique on those species for which it is applicable, higher yields will be expected. The manual sorting of other species is far too time consuming and so the presence of chaff should be accounted for when seeding. The recommended pre-treatment will also increase seedling yields, but economic factors will have to be considered before these are implemented. It may be less expensive to simply sow extra seed to increase the yields.

CONCLUSION

Low germination values were recorded for Eucalyptus accedens, E. calophylla and E. marginata. These low values could be due to dormancy and/or the presence of nonviable seeds. Viability tests and further germination trials are required to determine the optimum pretreatment for these species.

Soaking in water improved the germination of E. maculata and E. wandoo seeds. For all remaining species no pre-treatment significantly improved germination over that of the control material.

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TABLE 1. : Percentage germination of eleven *Eucalyptus* species after 21 days. Values sharing the same letter are not significantly different by the chi-square tests at $\alpha^1 = 0.01$ (2x2 Contingency Table). The sub-genus classification is based on Pryor & Jackson (1971):

S = *Symphomyrtus*
M = *Monocalyptus*
C = *Corymbia*

Species	Sub-genus	Treatments				Seed Scarified	Chi-square Test ($\alpha = 0.05$) (3x2 Contingency Table)
		Untreated Control	Soaked in water for 48 hours.	Soaked in 1% KNO ₃ for 48 hours.	Soaked in 1% KNO ₃ for 48 hours.		
<i>Eucalyptus accedens</i> W.V.Fitzg.	S	59	65	58	-		N.S
<i>E. calophylla</i> R.Br.	C	49	44	51	-		N.S
<i>E. camaldulensis</i> Dehn.	S	95	99	-	93		N.S
<i>E. gomphocephala</i> A.DC.	S	98a	90b	-	93ab		p<0.05
<i>E. laeliae</i> Podger & Chippendale	S	79	87	87	-		N.S
<i>E. lane-polei</i> Maiden	S	95	88	-	90		N.S
<i>E. maculata</i> Hook.	C	71a	94	-	82a		p<0.05
<i>E. marginata</i> Donn ex Sm.	M	42	19	-	3		p<0.05
<i>E. patens</i> Benth.	M	87a	94a	59	-		p<0.05
<i>E. resinifera</i> Sm.	S	80	82	-	76		N.S
<i>E. wandoo</i> Blakely	S	92b	98ab	-	100a		p<0.05

Footnote : For *E. gomphocephala* and *E. wandoo* the chi-square test was not capable of differentiating which group the 'seed scarified' and 'soaked in water' values, respectively, should belong to. This study has grouped them with the higher value.

TABLE 2. Recommended pretreatments (the pretreatment which gave the highest absolute percentage germination) for each species tested.

Species	Recommended pretreatment
<i>Eucalyptus accedens</i>	Soaked in water for 48 hours
<i>E. calophylla</i>	Soaked in 1% KNO ₃ for 48 hours
<i>E. camaldulensis</i>	Soaked in water for 48 hours
<i>E. gomphocephala</i>	No Treatment
<i>E. laeliae</i>	Soaked in water for 48 hours
<i>E. lane-poolei</i>	No Treatment
<i>E. maculata</i>	Soaked in water for 48 hours
<i>E. marginata</i>	No Treatment
<i>E. patens</i>	Soaked in water for 48 hours
<i>E. resinifera</i>	Soaked in water for 48 hours
<i>E. wandoo</i>	Scarify the seed

TABLE 3. Sorting technique used to separate seed and chaff.

Species	Sorting Technique
<i>Eucalyptus accedens</i>	Sieve with 0.85 mm screen
<i>E. calophylla</i>	Sieve with 3.35 mm screen
<i>E. camaldulensis</i>	Manual
<i>E. gomphocephala</i>	Sieve with 1.00 mm screen
<i>E. laeliae</i>	Manual
<i>E. lane-poolei</i>	Sieve with 1.00 mm screen
<i>E. maculata</i>	Sieve with 1.40 mm screen
<i>E. marginata</i>	Manual
<i>E. patens</i>	Manual
<i>E. resinifera</i>	Manual
<i>E. wandoo</i>	Manual