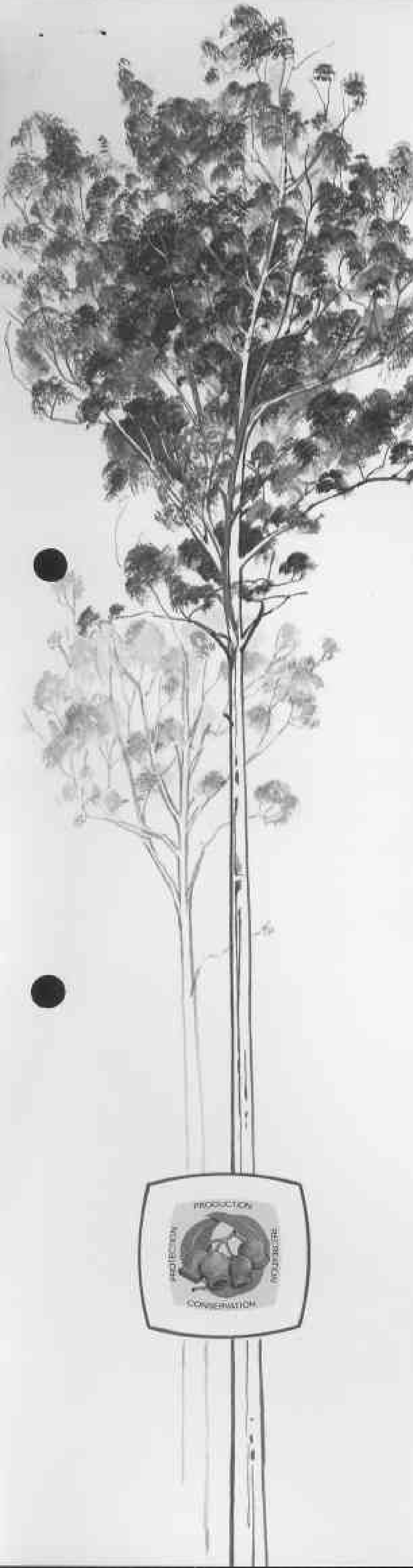

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SOME FACTORS AFFECTING THE GERMINATION OF KARRI (*Eucalyptus diversicolor* F.Muell.) SEED

by

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SUMMARY

Karri (*Eucalyptus diversicolor*) seed sown in autumn showed a higher rate of germination than seed sown in spring. The use of insecticides increased germination in both sowing seasons. Germination on non-ashbed sites was greater than on ashbed sites. The influence of fungicides, shade and soil type on germination was minimal, although the fungicides tended to decrease germination.

INTRODUCTION

The factors affecting seed germination and seedling survival are of prime importance in ensuring successful karri (*Eucalyptus diversicolor* F. Muell.) forest regeneration.

This is particularly so when regeneration is effected by means of natural seedfall, which is induced by regeneration burns in spring or autumn: the season of the burn is selected according to operational expediency. Although spring burns provide for adequate formation of ashbeds and removal of slash, regeneration results are often variable.

Christensen (1971) showed seedfall to be virtually complete within six weeks of a burn. No germination occurs before autumn, therefore seed shed after a spring burn lies on the ground throughout summer. Much of this seed may be lost as a result of insect damage or other factors (Loneragan, personal communication). Further research to establish the relative importance of some of these factors is therefore necessary.

This paper reports the results of experiments initiated to determine the effects of soil type, seedbed type, shade, insecticides and fungicides on the germination of karri seed following regeneration burning.

METHOD

Five sites, each of 0.36 ha, were chosen for the study. Two of the sites were in Gray Block, 26 km west of Manjimup, on a red loam soil, type Gn2.15 (McArthur and Clifton, 1975), which is typical of a pure karri site. The other three sites, one in Poole Block and two in Sutton Block, about 32 km south-east of Manjimup, were on yellow podsolic soils, type Dy3.62, which are typical of the mixed karri and marri (*E. calophylla* R. Br.) sites.

Spring regeneration burns were carried out on all five sites. On all sites except one (in Sutton Block), natural seedfall from seed trees retained after logging, at densities of four and five stems per hectare, was monitored using a technique developed by Wilm (1946).

On the remaining site, in Sutton Block, all karri seed trees were removed, to prevent natural seedfall on the site. Seed was then hand sown in this area.

Immediately after the burn, on each of the sites supporting seed trees, 7 randomly located plots, each of 0.4 m^2, were sown with 100 untreated seeds per plot to simulate natural spring seedfall. In April, 7 similar plots were sown in each area to simulate autumn seedfall.

Hand sowing in addition to distribution of seed by natural seedfall was necessary to ensure sufficient numbers of germinants for a proper statistical analysis. In all cases the seed used was obtained from a bulked store of seed collected throughout the main karri range.

On the Sutton Block site where all the seed trees had been removed, 80 plots each 0.4 m^2 in area were allocated equally between ashbed and non-ashbed seedbeds. Twenty plots of each seedbed type were sown in spring with 100 seeds each. The experiment was then duplicated on the remaining 40 plots in autumn. Within each set of 20 plots, 5 were given no treatment, 5 were dusted with dieldrin insecticide, 5 were dusted with zineb fungicide, and the remaining 5 were shaded by flywire screens. The insecticide and fungicide were applied at a rate of 2.5 g per plot, or 62.5 $kg \cdot ha^{-1}$. At these high rates the elimination of all insect and fungal depredation on the plots was ensured. The flywire allowed approximately 70% of available light to reach the seedbed.

The experimental design was a replicated factorial trial, with the type of seedbed (ashbed or non-ashbed) as the basic character. The variables listed above were each applied to the plots in five replications at each season of sowing.

RESULTS

Season of sowing

The germination percentages of karri seed in the different seasons of sowing at the four sites supporting seed trees

TABLE 1

Mean germination percentages of karri seed sown in different seasons

Soil type	Location	Season of Sowing	
		Spring	Autumn
Red loam Gn2.15*	Gray Block 1 Gray Block 2 Mean	2.9 7.9 5.4	5.4 9.7 7.55
Yellow podsolic Dy3.62*	Sutton Block Poole Block Mean	8.8 1.9 5.35	10.2 3.9 7.05

* reference descriptions from McArthur and Clifton (1975)

TABLE 2

Mean germination percentages of karri seed sown in different seasons, Sutton Block trial

Soil type	Location	Season of Sowing	
		Spring	Autumn
Yellow podsolic Dy3.62*	Sutton Block	3.45	9.15

* reference descriptions from McArthur and Clifton (1975)

N.B. The effect of dieldrin insecticide was negligible, and was not considered in these figures.

are shown in Table 1.

An analysis of variance of the results indicated no significant differences between the seasons of sowing for all four sites.

This could be due to variable seedfall from the seed trees, which would result in variable seed numbers on each plot; a correction factor derived from seed-tray results was applied to the data but was not satisfactory. The data show a trend, however, towards higher germination percentages in autumn. This is borne out by the more intensively replicated Sutton Block trial (Table 2) which shows significant differences ($p = 0.01$) between spring and autumn germination percentages. More intensive experiments on both soil types may help to clarify this.

Other factors

The results of the trial examining the effects of seedbed, insecticides, fungicides and shade on the germination of karri are shown in Table 3.

Seed germination on the plots treated with insecticide was significantly greater ($p = 0.01$) than the other treatments. Germination on non-ashbed sites was greater than on ashbed sites ($p = 0.05$). None of the other treatments gave rise to significant variation, although the fungicide appeared to inhibit germination.

DISCUSSION

In the intensively replicated Sutton Block trial (Table 2) significant differences between the germination percentages for spring and autumn sowings are apparent. This may be due to

TABLE 3

Mean germination percentages of karri seed subjected to various treatments on ashbed and non-ashbed sites

Treatment	Spring		Autumn		Spring	Autumn
	Ashbed	Non-ashbed	Ashbed	Non-ashbed	Mean	Mean
No treatment	3.2	3.8	11.6	9.2	3.5	10.4
Shade	4.8	2.0	5.2	20.8	3.4	13.0
Insecticide	10.8	12.6	24.4	34.2	11.7	29.3
Fungicide	1.2	5.6	0.6	7.4	3.4	4.0
Mean	5.0	6.0	10.5	17.9	5.5	14.2

depredation by insects on spring-sown seed, since germination in the insecticide-treated plots is greater for both sowing seasons (Table 3).

While both insecticide treatments significantly increased germination ($p = 0.01$) in comparison with germination on the corresponding untreated plots, the effect of the insecticide is greater in the autumn sowings. This may be because the dieldrin is leached or blown away, or possibly degraded, during the summer. This requires further research.

The trial confirms earlier work by Loneragan (personal communication), who observed insects to cause severe depredation of seeds and young germinants. Sowing techniques designed to minimize insect depredation would improve the effectiveness of seeding operations in the karri forest.

The observation that soil type has only minimal effect on karri germination is supported by Annels (1979), who carried out trials with clay-pelletted karri seed. This finding is relevant to the forest operations in the south-west of Western Australia, where mixed forests grow on podsolic soils, for it shows that artificial seeding can be applied similarly on both podsolic and red loam soils.

Ashbeds appear to have an inhibiting effect on germination, although they produce outstanding growth of the surviving karri germinants (Loneragan and Loneragan, 1964). In comparison with other karri forest soils, ashbed soils are less structured, contain less organic matter, and are more alkaline with an accumulation of soluble salts in the surface layer (Hatch, 1960). This may explain their tendencv to resist initial wetting at the beginning of autumn. These characteristics suggest a partial explanation of reduced karri seed germination on ashbeds.

When seed shed after a spring regeneration burn is left on the ground over summer, rainfall may be another important factor affecting its germination, since no seed was observed to germinate before the onset of the autumn rains. Earlier germination would probably have resulted in seedling dessication during the following hot, dry summer period.

In 1970, the year of the experiment, most seed germinated only after 50 to 75 mm of rainfall over a three-day period in April. This is supported by observations in the karri forest over many years. The 41 mm of rain that fell over three days during February failed to stimulate seed germination. This may indicate that dormancy is induced by heat as well as drought. Since rain falls in February in 60% of all years, it is important to understand any effects it may have on germination.

CONCLUSIONS

The study indicates several important points for consideration when planning karri regeneration operations. Autumn sowings, which lead to far higher germination percentages than spring sowings, require less seed for the same degree of regeneration.

The difference between the results from the two sowing seasons could be attributable largely to insect depredation, since germination increased significantly on spring-sown plots treated with dieldrin insecticide.

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