ODC 232.33:178.6

Research Paper 63
1980

FORESTS DEPARTMENT
OF WESTERN AUSTRALIA

ASPECTS OF SPOT SEEDING AND SEED PELLETING FOR THE REGENERATION OF KARRI (*Eucalyptus diversicolor* F. Muell.)

by
C.J. SCHUSTER

SUMMARY

The current seed application rate for broadcast seeding may be reduced by up to 40% by using the spot seeding technique for karri regeneration.

Varying the materials used for seed pelleting did not greatly increase seedling stocking at age one. It appears that stocking may largely be influenced by factors operating after the seedling has germinated.

INTRODUCTION

Several techniques are available for regenerating a karri (*Eucalyptus diversicolor* F. Muell.) forest coupe following logging. These include natural regeneration from seed trees, broadcast seeding (Annels, 1980), and hand planting nursery-raised seedlings. However, both artificial techniques have the disadvantage of high cost.

Research into the spot sowing technique which has been continuing for many years (O.W. Loneragan*,personal communication), has hence been intensified. The principle of the technique is to select sites for seeding which will favour germination and survival. Spot seeding would reduce the costs of the regeneration operation firstly because of the reduced dependence on a nursery infrastructure, secondly because the technique is less labour-intensive than hand planting, and thirdly because the technique uses far less seed than broadcast seeding.

This paper reports on three separate trials. The first two attempted to define the optimum application rate of seed for spot seeding. The third experiment examined the possibility of increasing the plant per cent (the percentage of seeds that have developed into seedlings at age one year) by varying the constituents of the seed pelleting mixture.

METHODS

Seed application rate

Details of the two trials initiated to determine the optimum application rate of seed for spot seeding are shown in Table 1.

Both trials were sown in late April (autumn), which is the optimum sowing season (Annels, 1980). In the Brockman Block trial (1978) only one seed per spot was sown throughout, as the Poole Block trial had shown little advantage in increasing seed application from 2 to 6 seeds per spot.

In both trials clay-pelleted seed was sown in a depression no more than 1 cm deep in the soil surface. The seeding spots were located on favourable sites (ashbed and disturbed mineral earth); compacted and unburnt sites were avoided.

In each trial the number of stocked spots was assessed on a central sub-plot within each treatment plot. In the Poole Block trial the number of seedlings per spot was also assessed. Data were then subjected to an analysis of variance, and were ranked using Duncan's Multiple Range Test (Duncan, 1955).

Seed pelleting

The current seed pelleting operation for karri, described by Annels (1980), is based on a system developed in Victoria (Forests Commission of Victoria, 1977). It is used in an attempt to reduce pre-germination losses of seed in the field and to allow for more efficient seed spreading.

The pellets contain an insecticide (DDT) and a fungicide (Thiram) bound around the seed with a water-soluble mucilage and a kaolin clay. This trial investigated germination and survival rates in response to variations in this composition. Details of the trial design and of the treatments tested are shown in Table 2. For all treatments, the quantities of materials in the pellet were the same as those in the current operational prescription: for every kilogram of pure seed, approximately 2 to 3 kg of coating, 0.65 kg of mucilage, 10 g of insecticide and 3 g of fungicide. One kilogram of pure seed contained approximately 5×10^5 seeds.

A replicate trial was performed in a glasshouse to determine the effect of the various pellet formulations on germination, without the influence of the external factors that would be present in the field trial. The glasshouse trial was conducted using a substrate of topsoil from the area of the field trial.

Both trials were established using a complete randomised block design, with three replications of the 45 treatments. The seed trays in the glasshouse contained 50 seeds on an area of 150 cm^2. The field trial plots were each 4 m^2, with raised borders between them to prevent wash, and each plot was sown with 100 seeds.

* Forests Department of Western Australia

TABLE 1

Establishment details of trials to determine the optimum rate of application of seed in spot seeding

Trial location	Year of establishment	Soil type*	Experimental treatments		Trial design	Treatment plot size (ha)
			Spots per ha	Seeds per spot		
Poole Block 21 km SE of Pemberton	1977	Dy5.81 Yellow podsol	1000 1750 2500	2 and 6	Complete randomised block (3 reps.)	0.15
Brockman Block 6 km ESE of Pemberton	1978	Dy3.62 Gravelly yellow podsol	3000 6000 9000 12000 15000 18000 21000 24000 27000 30000	1	Complete randomised block (3 reps.)	0.023

* Soil descriptions from McArthur and Clifton (1975)

TABLE 2

Establishment details of the trial to examine variations in the seed pelleting prescription

Trial location and date	Soil type*	Pelleting materials tested		
		Coatings	Fungicides	Insecticides
Nairn Block 15 km ESE of Pemberton established 1978	Dy3.62 Gravelly yellow podsolic	Kaolin clay Bentonite clay Magamp**	Captain A (a.i. 83% w/w Captan) TMTD (a.i. 80% w/w Tetramethyl thiuram disulphide) Zineb (a.i. 65% w/w Zineb) Cuprox (a.i. 50% w/w copper) Control (no application)	DDT Dieldrin Control (no application)

* Soil description from McArthur and Clifton (1975)

** Magamp is a slow-release N:P:K fertilizer (for this purpose it was crushed)

The glasshouse trial was assessed for seedling germination and survival at two-daily intervals from sowing for eight weeks. The field trial was assessed 12 months after sowing, and in both cases seedling numbers and a plant per cent were tabulated.

RESULTS

Seed application rate

The results of the Poole Block trial are shown in Table 3 (after Annels, 1980).

Adequate regeneration stocking was not achieved in any of the treatments in this trial. At present 1500 plants per hectare are required for satisfactory stocking in a direct seeding operation. No treatment in this trial exceeded 350 plants per hectare.

There is no great advantage in using more than two seeds per spot; the trial shows that increasing the sowing rate to six seeds per spot gives only a marginal increase in stocking. In any case, for each seeded site, only one seedling is required to stock it adequately.

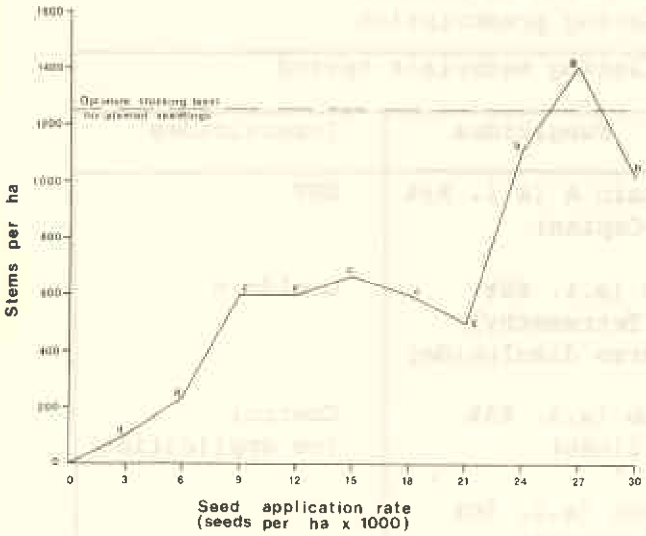

FIGURE 1: Karri seedling survival, Poole Block spot sowing trial, age 1 year. All data marked with the same letter are not significantly different (P=0.05, Duncan's Multiple Range Test; Duncan, 1955).

Plant per cent in this trial ranged from 2.33 to 6.25%. These figures are very low as karri seed normally has 95% viability; there has clearly been a large loss of viable seed or seedlings. However, they are higher than the plant per cent figures of 0.02 to 1.16% quoted by White (1971).

On the basis of the information from the Poole Block trial, the Brockman Block trial was sown at one seed per spot. The results from this trial are presented in Figure 1.

The trial indicates that an application rate above 24 000 seeds per hectare (at one seed per spot) may produce an acceptable regeneration stocking (Fig. 1). The low stocking in the 21 000 spots-per-hectare treatment was caused by overland water wash, which affected two replications of this treatment.

The 27 000 spots-per-hectare treatment produced significantly more ($p = 0.05$) seedlings at age one year than any other seeding rate. Generally seedling stocking increased with seeding rate.

Seed pelleting trial

The results of the glasshouse trial of seed pellet combinations are presented in Table 4.

Only the treatments using Magamp or the fungicide Captan A significantly reduced seed germination and survival when compared with other treatments.

The results of the field sowings of the various pelleting combinations are presented in Table 5.

The results indicate few significant differences in seedling establishment rate between the various pelleting compositions.

Bentonite produced a significantly higher ($p = 0.05$) seedling survival rate than did Magamp coating. For the insecticide treatment the control gave significantly higher seedling survival than did the DDT treatment, and dieldrin produced no better result than the control treatment. Captan and the control fungicide treatment produced lower seedling survival rates than the three other fungicides. However, no differences were

TABLE 3

Seedling establishment in the karri spot seeding trials in Poole Block, 1977

Sowing rates			Stocking rates			
Spots per ha	Seeds per spot	Seeds per ha	Stocked spots per ha	Seedlings per ha	Plant per cent	% of spots stocked
1000	2	2000	116	125	6.3	11.6
1750	2	3500	150	158	4.4	8.3
2500	2	5000	175	191	3.4	7.0
1000	6	6000	133	141	2.4	13.3
1750	6	10500	233	308	2.9	12.0
2500	6	15000	316	350	2.3	12.7

(after Annels, 1980)

TABLE 4

Mean plant per cent for all pelleting materials (glasshouse trial)

Pellet			Insecticide			Fungicide				
B	K	M	Dd	D	Co	Ca	Cu	T	Z	Co
30.3 a	42.1 a	10.3 b	24.8 a	29.7 a	28.1 a	18.2 b	28 a	25.1 a	30.4 a	36.0 a

Within each class of material, data notated with the same letter are not significantly different at p = 0.05 (Duncan's Multiple Range Test, Duncan, 1955)

B = Bentonite
K = Kaolinite
M = Magamp

Dd = DDT
D = Dieldrin
Co = no application

Ca = Captan
Cu = Cuprox
T = TMTD
Z = Zineb

TABLE 5

Mean plant per cent for all pelleting materials (Nairn Block trial)

Pellet			Insecticide			Fungicide				
B	K	M	Dd	D	Co	Ca	Cu	T	Z	Co
7.0 a	5.3 ab	3.5 b	4.5 b	4.9 ab	6.2 a	4.1 a	5.0 a	5.5 a	5.3 a	4.6 a

Within each class of material, data notated with the same letter are not significantly different at p = 0.05 (Duncan's Multiple Range Test, Duncan, 1955)

B = Bentonite
K = Kaolinite
M = Magamp

Dd = DDT
D = Dieldrin
Co = no application

Ca = Captan
Cu = Cuprox
T = TMTD
Z = Zineb

significant at $p = 0.05$.

DISCUSSION

The Brockman Block trials (Fig. 1) indicate that a seeding rate of 24 000 to 27 000 seeds per hectare may be sufficient to ensure an adequate stocking of regeneration in a karri forest coupe. This compares very favourably with the current broadcast seeding application rate of 45 000 seeds per hectare.

The plant per cent of all the treatments shown in Figure 1 varied mainly within the range 3 to 6%. This low rate of seed germination and seedling survival means that a great deal of the seed spread during a sowing operation is wasted. Given the current high cost and limited availability of karri seed, any technique that can increase the plant per cent would be important.

Seed pelleting is a potential method for improving pre-germination seed survival. However, the seed pelleting trials reported in this paper indicate that while small improvements may be made in the current seed pelleting process, they still result in a maximum plant per cent of 6 or 7% below that achieved under field conditions. Christensen and Schuster (1979) found similar limits on seedling establishment using uncoated seed, where the plant per cent obtained with autumn sowing was 10.4%. Loneragan (personal communication) obtained a figure of 5% using clay-pelleted seed.

The trials indicate that the optimum mix to use with the current pelleting process includes bentonite clay, either dieldrin or no insecticide, and TMTD or Zineb fungicide. However, the potential gains from altering the current system are small.

The low plant per cent obtained with sown seed (pelleted or not) and the high viability of karri seed (approximately 95%) indicate that external factors after germination may be vital in determining the seedling establishment rate. These factors could include insects, fungi, frost, wash by water, and desiccation.

The poor response to the inclusion of insecticide in the pellet may indicate that attack by insects is not important; however, trials by Christensen and Schuster (1979) indicate that this is not the case. It may also indicate that either the insecticide is not added to the pellet in sufficient quantities to deter attack, or that damage of seedlings following germination, when the pellet does not protect them, is far more important. The same reasons may explain the lack of response to the inclusion of fungicides in the pellet.

FURTHER RESEARCH

Several avenues of research should be pursued to clarify points raised in this study.

Firstly, the optimum pelleting mix (bentonite, dieldrin and TMTD) should be tested to determine the effects of varying the application rates of material in the pelleting mixture.

Secondly, the optimum spot seeding rate, 27 000 seeds per hectare, should be used to determine the effect of seed placement on the success of seedling establishment. For example, it may be possible to devise a technique to reduce insect damage to seedlings.

Thirdly, the effect of insects and fungi on seedlings after germination should be examined, to determine the role they play in regeneration success or failure.

CONCLUSIONS

The spot seeding technique used to apply seed at a rate of 27 000 spots per hectare (one seed per spot) can be used to satisfactorily regenerate a cut-over karri coupe.

Attempts to improve the plant per cent by amending the seed pelleting technique have met with little success. This is attributed to the fact that only limited quantities of chemicals can be contained in the pellet, and perhaps more importantly to seedling depredation following germination, when the pellet is no longer protective.

The pelleting mixture of bentonite clay, dieldrin insecticide and TMTD fungicide proved most successful, and has been selected for further study.

REFERENCES

ANNELS, A.R. (1980). Artificial seeding of karri (*Eucalyptus diversicolor* F. Muell.). Research Paper 59, Forests Department of Western Australia.

CHRISTENSEN, P.E.S. and SCHUSTER, C.J. (1979). Some factors affecting the germination of karri (*Eucalyptus diversicolor* F. Muell.) seed. Research Paper 50, Forests Department of Western Australia.

DUNCAN, D.B. (1955). Multiple Range and Multiple *F* tests. Biometrics 11, 1-42.

FORESTS COMMISSION OF VICTORIA (1977). Seed Coating - Eucalypts. Operational Information No. 9, Division of Forest Operations.

McARTHUR, W.M. and CLIFTON, A.L. (1975). Forestry and agriculture in relation to soils in the Pemberton area of Western Australia. Soils and Land Use Series 54, Division of Soils, CSIRO, Australia.

WHITE, B.J. (1971). Karri silvics. Research Note, Forests Department of Western Australia.