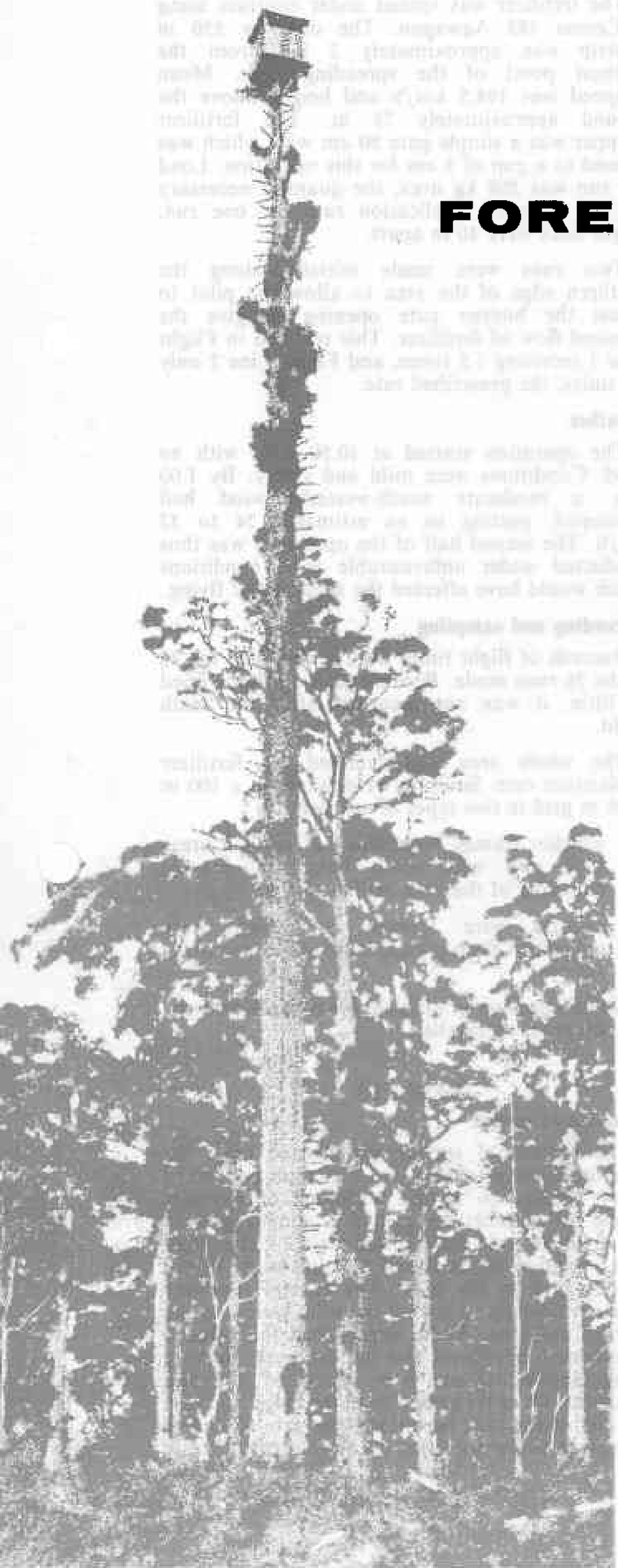
Research Paper No. 26

1976



FORESTS DEPARTMENT

OF WESTERN AUSTRALIA

54 BARRACK ST., PERTH

AERIAL APPLICATION OF UREA FERTILIZER TO JARRAH POLE STANDS

by

P. C. KIMBER

SUMMARY

Urea prills were aerially applied to jarrah pole stands in south Western Australia. This paper describes the method and problems. Sampling of the fertilizer application rate showed an unacceptably high variation in spread compared with standards achieved elsewhere. In this trial only every fifth flight line was marked and the high variation in spread is mainly attributed to leaving the 4 unmarked flight lines between to the judgement of the pilot.

INTRODUCTION

Small-scale trials initiated over the past 6 years have shown conclusively that pole and small pile-sized jarrah up to 142 cm gbh show a marked response to fertilizer. On 21 September 1972 urea was applied aerially at 237 kg/ha to a 72.8 ha block of approximately 40-year-old poles, 9.5 km east of Dwellingup. The objectives of the trial were:

1. to study the magnitude and duration of the response to fertilizer under field conditions;
2. to gain some insight into the practice and problems likely to arise under operational conditions.

This paper deals with objective 2 only.

Aerial spreading was chosen in preference to ground application because of uneven terrain, and because fallen trees and rock on the forest floor would have made access difficult and track preparation costly for this short-term venture. In addition, readily available ground spreading equipment gives grossly uneven rates of application across the swath (Britten and Rose, 1959).

METHOD

The area

The 72.8 ha block to be fertilized was 2 012 m long and 362 m wide. Flight lines were planned along the length of the block. The crop consisted primarily of poles up to 27 m high with a few older trees reaching 35 m. The area sloped gently to moderately across its width, the upper boundary roughly following a ridge-top. A bluff protruding above the centre of the area restricted vision during low flight. This effect was localized to one-third of the flight lines.

Marking flight lines

The basic marking system was to mark every fifth flight line by a tethered bunch of 4 red balloons each of about 350 mm diameter. On flight lines affected by the bluff, the balloons were placed in the centre as well as at the end. The pilot normally carried out 4 unmarked runs between each marked one. However, in one instance the 4 flight lines unmarked by balloons were marked by Verey flares fired from the opposite end of the flight line.

Communications

There was a V.H.F. link between the plane and the loading truck. The airstrip controller and the men responsible for the western and central lines of markers communicated by walkie-talkie radio. The eastern end markers were in contact with the airstrip controller by V.H.F. radio because walkie-talkie contact could not be made.

The operation

The fertilizer was spread under contract using a Cessna 185 Agwagon. The one-way 550 m airstrip was approximately 2 km from the furthest point of the spreading area. Mean airspeed was 194.5 km/h and height above the ground approximately 75 m. The fertilizer dropper was a simple gate 50 cm wide which was opened to a gap of 5 cm for this operation. Load per run was 508 kg urea, the quantity necessary for the required application rate for one run. Flight lines were 10 m apart.

Two runs were made initially along the southern edge of the area to allow the pilot to adjust the hopper gate opening to give the required flow of fertilizer. This resulted in Flight Line 1 receiving 1.5 times, and Flight Line 2 only 0.5 times, the prescribed rate.

Weather

The operation started at 10.50 a.m. with no wind. Conditions were mild and sunny. By 1.00 p.m. a moderate south-westerly wind had developed, gusting to an estimated 24 to 32 km/h. The second half of the operation was thus conducted under unfavourable wind conditions which would have affected the accuracy of flying.

Recording and sampling

Records of flight times were maintained for 28 of the 36 runs made. Because loading time varied so little, it was not recorded after the tenth flight.

The whole area was sampled for fertilizer application rate. Samples were taken on a 100 m × 20 m grid in two types of catcher:

1. wooden frames 7 cm deep of surface areas 1974 cm^2 with cloth bases to prevent bouncing of the urea prills;
2. circular wire frames on which were suspended deep plastic bags of surface areas 729 cm^2.

No comparison of efficiency was made between the two types of catcher.

RESULTS

Evenness of spread

The pattern of spread was plotted from the samples collected. There was a distinct pattern of heavy application at the beginning of the run, tailing off towards the centre; a similar pattern was evident over the second half of the area. This variation is attributed to adjustment of the hopper gate by the pilot. The central rise may have periodically restricted the pilot's view of the marker balloons. As he approached the ridge it is assumed he closed the hopper gate slightly, being unable to see how much of the run remained. Once he passed over the ridge and saw the end of the run, he opened the gate to ensure that all fertilizer was used up on that run.

Two frequently used methods of quantifying the evenness of spread are the Half Value (HV) and the Uniformity Quotient (UQ): HV is the percentage of sample points that receive less than half the desired rate of application; UQ is the sum of the heaviest 50% of samples divided by the sum of the lightest 50%.

For this operation HV = 36.6 and UQ = 4.67. The acceptable UQ in aerial operations in Sweden is 3. Values of 2.16 (Queensland), 2.04 (Victoria), and 1.33 (Western Australia) have been achieved in the field using superphosphate fertilizer on young pine plantations. Thus, by comparison with established standards, the variation within this trial was unacceptably high.

Time per run

Loading time was defined as the interval between when the plane stopped in loading position and the start of take-off for the next run. For the first three runs, loading time was 27 s (seconds). The operation then settled to a mean time of 21 s (range 16 s to 23 s). Flying time included all the time the plane was moving, both on and off the ground. The mean flying time per run was 4 min 36 s (range 4 min 19 s to 4 min 55 s). Therefore the mean time per trip was 4 min 57 s.

Timed runs for superphosphate spreading over a pasture located a similar distance from an airstrip were made by research staff on private property in the Dwellingup area. The mean time per trip was a few seconds under 4 min. This time difference between an agricultural and a forestry application was due to the greater altitude required to clear tall trees in the forest situation. The greater altitude required for fertilization of tall crops is likely to be a permanent source of increased cost. By siting airstrips on the highest elevations these difficulties could be overcome to some degree.

Cost

Table 1 lists operational costs.

TABLE 1

Operational costs	$
17 250 kg urea in bags	1 360
Urea delivery, Kwinana to airstrip	100
Contract for flying	230
Sundries (balloons, string, gas)	30
Labour for hand-loading bagged urea (estimated)	20
	$1 740

The cost per hectare was $23.90. This does not include overheads, administration, or the cost of manning marker balloons which was done by salaried officers. A reduction of 6% in costs could be made by using urea in bulk instead of in bags.

DISCUSSION

The very uneven spread of fertilizer achieved in this trial warranted investigation. An analysis of the factors affecting spread is made below, highlighting points relevant to this trial, and areas where improvement would be possible.

Height of fertilizer drop

Swath width increases with the height of drop for application rates up to 18 kg/ha, but not at higher rates (Trayford and Treymayne, 1966; Scott, 1970). Increased height also improves the evenness of spread of fertilizer across the swath, reducing the peaking effect at the swath centre.

The fertilizer application rate in the trial was too high for swath width to be affected by the height of the drop. The effect of peaking in fertilizer distribution across the swath would have largely been eliminated by the wide overlap of swaths. Flight lines were 10 m apart, and the measured swath width on the ground was 35 m.

Wind

A strong side wind deflects the fertilizer swath to one side and, if it is gusty, may seriously affect the evenness of distribution. Baxter (1972) recommended confining aerial fertilizer applications to windspeeds of less than 24 km/h.

The wind effect was not the apparent cause of uneven spread as there was no difference in fertilizer distribution between the mild conditions of the first half and windy conditions experienced later.

Flight-line separation

If the rate of flow of fertilizer from the aircraft hopper, the speed of the aircraft, and the width of fertilizer swath when it reaches the ground are known, then the distance between flight lines can be accurately calculated. Flight-line separations were calculated in this way.

It appears that marking every fifth flight line in this trial was inadequate for the close separation of 10 m that was used, and inaccurate flying as a consequence was assumed to be the cause of the unsatisfactory spread of fertilizer. The ideal would be to mark every line.

Flight-line marking in tall, unevenly spaced crops presents a difficult problem. Armson (1972) reports that in Canada the treatment with silvicide of a few trees along some flight lines has proved a successful flight-line marker. Dexter of the Victorian Forests Commission (personal communication) has used jets of water from high pressure hoses in 20 m high pine plantations.

REFERENCES

ARMSON, K. A. (1972). Fertilizer distribution and sampling techniques in the aerial fertilization of forests. Tech. Rep. Fac. Univ. Toronto 11.

BAXTER, B. D. (1972). Personal communication regarding Victoria Forests Commission trials.

BRITTEN, F. R. J., and ROSE, G. J. (1959). The distribution of granular fertilizer from light aircraft. Rep. first int. agric. Aviation Conf., 210-220.

HAVEL, J. J. (1971). Fertilizer applications in young pine plantations. Unpublished departmental report. For. Dep. W. Aust.

POWELL, R. A. (1959). The distribution of different physical forms of nitrogenous fertilizer when applied from the air. Rep. first int. agric. Aviation Conf., 160-169.

SCOTT, R. S. (1970). Spatial distribution of fertilizer and seed applied from light aircraft. III. Effect of altitude, crosswinds and fertilizer material. N.Z. J. Agric. Res. 13, 909-920.

TRAYFORD, R.S. and TREYMAYNE, E. C. (1966). The effect of four factors on the aerial spreading of superphosphate. Flight Note 40. Aeronautical Research Laboratories, Dep. Supply, Melbourne.

102383/11/76—1M—M875

WILLIAM C. BROWN, Government Printer, Western Australia