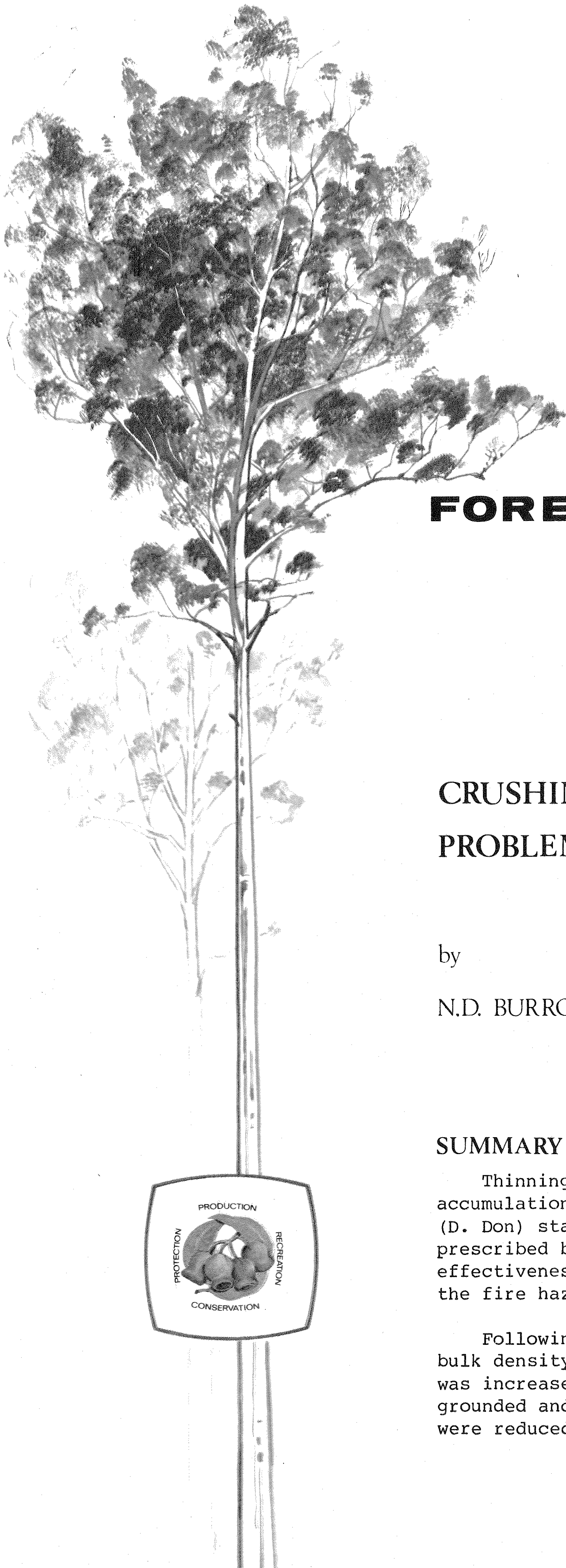
ODC 432.16:174.75

Research Paper 62
1980



FORESTS DEPARTMENT
OF WESTERN AUSTRALIA

CRUSHING THE THINNING SLASH PROBLEM

by

N.D. BURROWS

SUMMARY

Thinning and pruning operations result in an accumulation of flammable fuels under *Pinus radiata* (D. Don) stands. Because of the difficulties of prescribed burning in *P. radiata* plantations, the effectiveness of mechanically reducing fuels to reduce the fire hazard has been examined.

Following crushing by a Holt Scrub Roller, the bulk density of thinning slash older than six months was increased by up to 700%, aerial needles were grounded and flame heights and rates of fire spread were reduced by up to 65%.

INTRODUCTION

During the long fire season in Western Australia, a high fire danger exists in *Pinus radiata* (D. Don) plantations following thinning and pruning operations. Wildfires in these plantations are difficult to control because of the highly flammable nature of the fuels. *Pinus radiata* is fire-sensitive and is either killed or damaged by wildfire.

An obvious measure to reduce this hazard is to reduce the fuels by prescribed burning (McArthur, 1962). This treatment can be applied successfully to pines only under a very narrow range of climatic and fuel moisture conditions, so that it is often difficult to carry out burns.

This study was therefore undertaken to measure the feasibility and effectiveness of mechanically reducing slash fuels by compaction and by the reduction of particle size.

The effectiveness of treatment was determined by measuring the compaction of fuels of various ages and by comparing the fire behaviour of treated and untreated fuels.

METHOD

A Holt Scrub Roller (Fig. 1) towed by a 4 x 4 Fordson County rubber-tyred tractor was used to treat slash resulting from a commercial first thinning in 14-year-old *P. radiata*, planted at a spacing of 2.4 x 2.4 m.

Three slash ages were identified by needle colour. To determine the optimum age for mechanical treatment, the slash height was measured before treating at intervals of 5 m along 100 m line transects. For each slash age, five transects were assessed. After treatment, the slash height was re-measured at the same intervals along the transects to gauge the compacting and breaking effect of the roller. The diameter and moisture content of woody material broken by the treatment were also recorded.

To measure fire behaviour, fires were lit and monitored in two treated and two control (untreated) plots of 0.5 ha each, in eight-month-old *P. radiata* thinning slash. Fuel quantities were similar (36 $t{\cdot}ha^{-1}$). All plots were lit by a line of fire on the southern edge at the same time, to ensure uniformity of weather conditions. The environmental conditions that determined fire behaviour were:

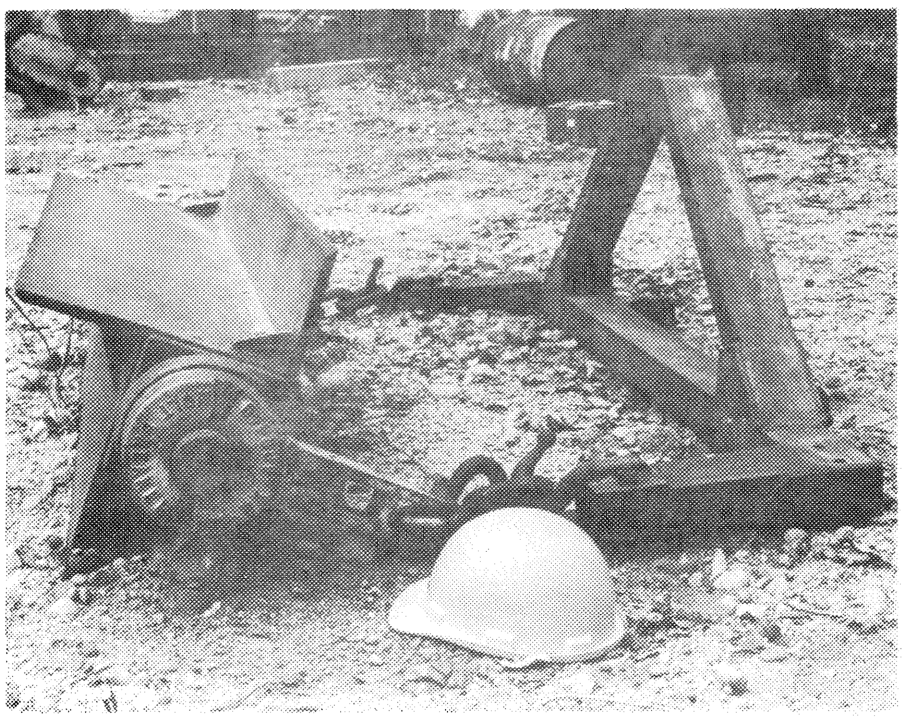


FIGURE 1: Scrub roller used for crushing thinning slash

Wind: SW at 4.5 $km \cdot h^{-1}$ (in the stand at 1 m above the ground)
Temperature: 19°C (at 1400 hours - ignition time)
Relative humidity: 42% (at 1400 hours - ignition time)
Cloud: Nil
Surface fuel moisture content: 19%
Profile fuel moisture content: 74%
Aerial fuel moisture content: 15%

Fire behaviour data were recorded and a post-burn assessment of the quantity of fuel removed and damage to the stand was made.

RESULTS AND DISCUSSION

Slash fuel is most effectively reduced by the scrub roller when the slash is 20 months old or older (Table 1). At this age the grey needles and wood are low in moisture content and therefore are very brittle and amenable to mechanical breakdown. With a wood moisture content of less than 15%, branches up to 2 cm in diameter are sheared, and aerated fine fuels (needles) are grounded. As well as immediately reducing the fire hazard, the action of grounding needles and breaking woody fuels probably enhances the biological breakdown of fuels.

Slash fuels six months old (red needles) are also considerably reduced both in aeration and particle size. As it is desirable to reduce the fire hazard as soon as possible following stand improvement operations, six months is the optimum time at which to treat slash. Mechanically treating two- to three-month-old slash is ineffective because of the higher moisture content and therefore greater flexibility of the wood.

Fire in mechanically treated slash burns at reduced intensity and has a reduced rate of spread and lower flame heights than in untreated slash. The data shown in Table 2 are typical for the mild fire weather conditions under which the study was carried out.

The differences in fire behaviour are due to the increased bulk density (reduced aeration) of the fine fuels following treatment. Another contributing factor is the breaking up of the previously

TABLE 1

Compaction and break-up by the Holt Scrub Roller on *P. radiata* thinning slash of various ages

1(1)	2	3	4	5	6	7	8	9
20	Grey	0.36	0.05	10*	72*	95	10	4
7	Red	0.62	0.20	6*	19*	90	15	2
2	Green	0.55	0.53	5	5.3	10	105	0.5

* Differences between initial and final bulk densities for 20- and 7-month-old slash are significant at the 0.05 probability level (determined by Student's t test)

(1) <u>Key to headings</u>

1 = slash age (months)
2 = slash needle colour
3 = mean initial slash height (m)
4 = mean final slash height (m)
5 = mean initial bulk density ($kg \cdot m^{-3}$)
6 = mean final bulk density ($kg \cdot m^{-3}$)
7 = aerial needles grounded (%)
8 = moisture content (of oven-dry weight) of woody material (%)
9 = maximum diameter of woody material broken (cm)

TABLE 2

Some effects of fires in mechanically treated and untreated *P. radiata* slash fuels

	1 (1)	2	3	4	5	6	7	8	9
Treated	63#	12	95	4	2	28	0.5	1.5	70.5*
Untreated	72#	10	98	2	3	57	2.0	4.0	145.0*

Difference is significant at the 0.001 probability level (determined by Student's t test)

* Difference is significant at the 0.05 probability level (determined by Student's t test)

(1) Key to headings

1 = mean removal of needlebed (%)
2 = standard deviation
3 = mean removal of aerial needles (%)
4 = standard deviation
5 = range of wood diameters removed (cm)
6 = mean forward rate of spread ($m \cdot h^{-1}$)
7 = mean flame height (m)
8 = mean scorch height (m)
9 = mean intensity ($kJ \cdot m^{-1} \cdot s^{-1}$)

continuous fuel bed.

Fire in the untreated plots consumed fuel at a greater rate and so generated more heat per unit time. Fuel pre-heating was amplified, leading to the combustion of wood of a larger diameter and 9% more needlebed. This figure is significant ($p = 0.001$).

Tree damage attributable to fire was limited to scorch of the first whorl of branches in the control plots, with no scorch evident in the treated plots. Minor cambial damage occurred in 5% and 10% of the trees in the treated and untreated plots respectively. The relatively low fire intensities account for the low degree of tree injury. Further experimentation under warmer weather and drier fuel conditions would probably show a far greater degree of tree damage in the untreated plots.

CONCLUSION

Mechanical treatment of thinning slash older than six months reduces the fire hazard under 14-year-old *P. radiata* stands. Treatment does not remove the hazard but reduces flame heights, rates of spread and fire intensity, and this is an advantage in suppression operations.

It is probable that treated stands would suffer less damage than untreated stands during a wildfire.

The increased decomposition rate of mechanically crushed fuels may also promote nutrient cycling within the stand.

The combination of tractor and Holt Scrub Roller could be improved upon becaus. it was not sufficiently robust and lacked manoeuvrability. Wider planting spacings - at least 3 m between the rows - are desirable to permit easy access by tractors.

REFERENCES

McARTHUR, A.G. (1962). Control Burning in Eucalypt Forests. Leaflet 80, Forestry and Timber Bureau, Canberra, Australia.