Fire Management Branch
Department of Conservation & Environment

USING FIRE TO REDUCE AERIAL FUELS IN FIRST THINNED RADIATA PINE

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SUMMARY

Dead needle fuels (aerial fuels) in the lower crowns of thinned radiata pine can be effectively reduced with low intensity fire. The technique relies heavily upon careful definition of a fuel moisture differential between the aerial fuels and ground fuels such that the ground fuels will not ignite. Crown scorch and stem damage can be avoided if burning is carried out under mild conditions in winter or spring. Plantation protection is substantially improved particularly if, at a later stage, low intensity fire is used to reduce the quantity of fuel resulting from thinning.

INTRODUCTION

Following canopy closure the dead needle fuels contained in the lower crowns of young radiata pine *(Pinus radiata, D Don)* contribute substantially to the level of fire hazard within a plantation. These aerial fuels, which can comprise up to 2.6 t/ha of the total fuel complex (Williams, 1977) are the link through which ground fires can readily extend into tree crowns. Crown fires may be impossible to control and the losses caused will be greater than in fires which remain ground or surface fires.

Low pruning is one method often used to break the link between ground and crown fuels although it is expensive and usually limited to creating a vertical gap in the fuel of about two metres. Unless it is followed by some technique which removes the pruning slash the advantage gained is largely offset in the ensuing one to two years by the increased fuel quantity at or near ground level. In stands aged 11 years or older low intensity fire may be used to reduce this fuel quantity (Thomson, 1978; Billing, 1979).

First thinning substantially alters the horizontal distribution of fuel within the tree crown level. The more discontinuous fuels which result allow low intensity fire to be used, as an alternative to pruning, to create an effective break in the vertical distribution of fuel. This report discusses the use of fire to remove aerial fuels and is based upon work conducted in the Kentbruck Plantation, Heywood District.

BURNING GUIDELINES

Using fire to reduce aerial fuels was referred to by Billing (1979) in a report which discussed fuel reduction burning of first thinning slash. This initial work indicated there was a range of conditions under which aerial fuels could be burnt without fire spreading into the ground fuels. In subsequent years more experimental work was carried out, including operational trials, to better define suitable burning conditions. The stands concerned were all 16 to 18 years old, site quality 2 to 3 and first thinned to approximately 700 stems/ha by removing every fifth or sixth row and further thinning in retained rows. Figures 1-3 illustrate typical fuel distribution before and after thinning.

Figure 1 Fuel distribution typical of an unthinned and unpruned stand at 16 years.

Fig 2

Fig 3

Figures 2 & 3 Fuel distribution after first thinning at 16 years.

The burning prescription shown in Table 1 has been established from the fire behaviour information shown in Appendix 1.

TABLE 1: PRESCRIPTION FOR BURNING AERIAL FUEL

NEEDLE MOISTURE CONTENTS (%)[1]		BACKGROUND CONDITIONS[2]			
Ground[3]	Aerial	Temp (°C)	RH(%)	Wind (km/hr)	BKDI[4]
>25	25-35	< 15	> 75	< 5	< 50

1 All fuel moisture contents mentioned in this report are expressed as a percentage of weight after oven drying at 105°C.

2 All background conditions are measured within the stand.

3 Elevated needle fuel on thinning slash.

4 The Byram-Keetch drought index measured in points.

The prescription is conservative, as an examination of the data in Appendix 1 will show, and successful burning has in fact been carried out with aerial fuel moisture contents as low as 20%. However, until considerable experience and confidence with this type of operation is obtained the prescription should be used as the basis for all operations.

This type of operation depends almost entirely on the presence of different moisture levels within the ground and aerial fuels. The moisture differential keeps the overall intensity low by mainly confining the fire to the aerial fuels. Under low windspeeds a moisture content greater than 25% in the elevated needles of the slash should ensure insignificant spread occurs at ground level, although fuels near the base of some trees will ignite. At the prescribed moisture levels, and depending on fuel density, flames may penetrate the aerial fuels to a height of 10-12 m although 5-6 m is more usual. With moisture contents greater than 35% the fuel will be difficult to ignite and a poor result is likely. Note that because the fuels concerned are well aerated, and those higher up the tree are exposed to maximum pre-heating, the moisture limits are higher than those which can be used for burning ground fuels. The rate of flame penetration can vary from 20 m/min at

Fig 4

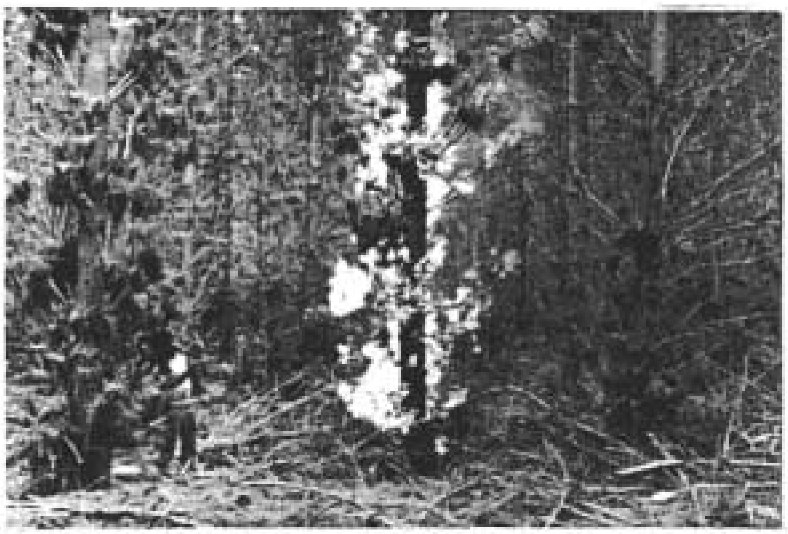


Fig 5

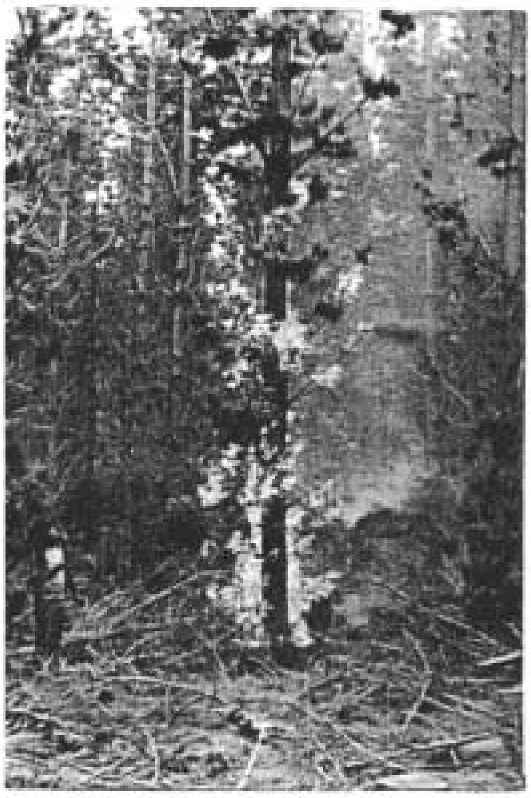
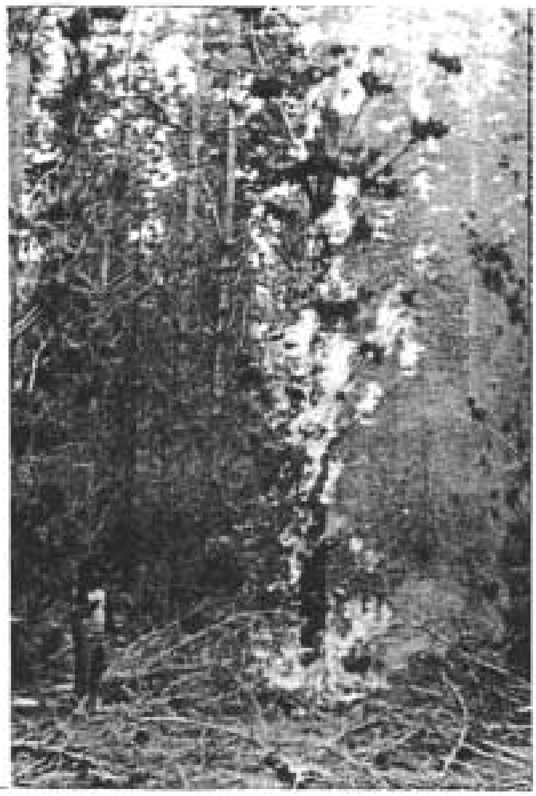


Fig 6



Figures 4 - 6 A sequence showing typical fire behaviour under the conditions defined in Table 1. This fire did not spread in the ground fuels.

moisture contents of 20%, to less than 7 m/min at the higher moisture levels. Illustrations of fire behaviour are given in Figures 4-6.

The Speedy Moisture Tester (Dexter and Williams, 1976) must be used to determine if aerial and ground fuel moisture contents are suitable, and the extensive sampling required prior to ignition, and throughout the burning period, is a full time job for one person. After burning has commenced sampling in the fuels ahead of the lighting crew will help to indicate if conditions are changing so rapidly that lighting should cease, or if some change in the lighting pattern is required. The prescription refers to minimum rather than average moisture content and at each sampling location fuels should be selected from the driest positions. Within the aerial fuels particular care is required because the driest fuels do not always occur in the outer layers of the lower crown. The increased exposure, and therefore reduced fuel moisture levels, brought about by such factors as roads, firebreaks and different stand and topographical conditions should be taken into account when sampling locations are being determined.

While the presence of a fuel moisture differential is vital to the success of the operation, the background conditions which apply are also important, particularly if stem damage and scorch levels are to be minimised. The major influence of temperature and relative humidity is on fuel moisture content, but limiting conditions for each have been specified to emphasise the mild burning conditions required. Burning under low temperatures reduces the likelihood of stem damage or crown scorch because the temperature rise which must be induced to reach the damage threshold is increased. A light wind within the stand, up to the recommended maximum of 5 km/hr, can also help by directing convective heat away from the stem and crown. Provided burning is conducted in winter or spring with a BKDI less than 50 large dead branches within the crown are unlikely to ignite and contribute to stem damage.

In a prescribed burning operation both the rate and pattern of lighting help to determine fire intensity. The intensity can be kept low by staggering the lighting pattern so that trees in alternate rows, or row pairs, can be lit and allowed to burn out before lighting adjacent rows. During most operational trials at Heywood, adequate intensities were maintained by allowing only two adjacent rows within each bay to be alight at any one time. Crew members using drip torches walked between the rows lighting the lower crown of each tree as they passed.

The major control measure required in this type of operation is close supervision of the lighting crew. Even though trees on several hectares may be alight if a large crew is working, the rapid burn out time for the fuels in each tree of less than 5 minutes means the operation can be stopped quickly if necessary.

COSTS AND DAMAGE

Experience at Heywood has shown that a lighting crew of 8 men can cover about 12 hectares per hour (1.5 ha/man hour) to give a labour cost of approximately $6/ha. This is small when compared to low pruning where costs in an 8 year old stand, based upon a working rate of one hectare per 100 man hours, can be as high as $900/ha. The high cost, combined with poor productivity, limits the application of pruning to small strategic areas.

If the prescription is followed, and lighting implemented with care, damage should be insignificant. However, in those sections of the trials at Kentbruck where most of the ground fuels as well as aerial fuels were burnt, crown scorch and stem damage was recorded. In particular, damage was found at levels above 2-3 m from the ground where the bark becomes quite thin. Any operation in which either the ground fuel or bark near the base of the tree ignites and continues to burn, or where large dead branches in the crown ignite, should be stopped.

INTEGRATION OF BURNING OPERATIONS

From about age 11 years, and under carefully prescribed conditions, low intensity fire can be used to reduce ground fuel quantities in radiata pine plantations. Prescribed burning can be particularly valuable in areas that have recently been first thinned and in which the slash is not compacted or broken down during the thinning operation.

In strategic areas, or simply in sections designed to break up extensive areas of slash fuels, a two-stage operation comprising burning of aerial fuels followed at a later stage by reduction of the ground fuels can provide vastly improved plantation protection.

ACKNOWLEDGEMENT

This work could not have been undertaken without the assistance of the staff and employees of the Heywood District.

REFERENCES

BILLING, P R (1979) Using fire to reduce fuel accumulations after first thinning in radiata pine plantations. Forests Commission Victoria Fire Research Branch Report No 4 (unpublished).

DEXTER, B D and WILLIAMS, D F (1976) Direct field estimation of fine fuel moisture content. Aust. For. 39(2) 140-144.

THOMSON, D S (1978) Low intensity prescribed burning in three Pinus radiata stand types. Forests Commission Victoria Fire Research Branch Report No 2 (unpublished).

WILLIAMS, D F (1977) Influence of fuel quantity, distribution and moisture content on fire management of radiata pine plantations. M F Thesis, University of Melbourne.

APPENDIX I - FIRE BEHAVIOUR INFORMATION

DATE	TIME/ PERIOD	TEMP (°C)	RH (%)	MOISTURE CONTENT (%)	WIND SPEED (km/hr)	FIRE BEHAVIOUR COMMENTS
8/9/1977	1245-1300	15	70	21	0-5	Vertical spread very fast.
9/9/1977	0935-1145	11.5-12.5	90	43-46	0	Ignition difficult but fires still spread
28/9/1977	2200-2300	14-15	73-76	23.5-25.6	0-5	Good effect.
1/11/1977	1240-1700	14.2-16.5	76-93	18.5-22.0	0-5	Ground fires ignitin Too dry.
10/5/1978	1400-1710	10-12.5	68-76	24-27	3-5	Fuels ignite readily
17/5/1978	1300-1445	13.2-16.0	63-96	21.8-30.6	2-3	Good range of fire behaviour
13/7/1978	1330-1700	10-14	63-90	35.5-46.2	0-3	Fires difficult to ignite.
16/10/1979	1430-1740	13-17	60-85	22-26	0-10	Ground fuels too dam Good fire behaviour.
17/10/1979	1400-1600	15-17	68-72	20.8-22	0-5	Ground fuels too dam Good fire behaviour.
5/9/1980	0915-1400	15-17	68-80	19-23.2	0-10	OK at first but becoming too dry. Satisfactory at high MC.
9/10/1980	1245-1600	13-18	65-92	20-24.3	0-5	Good fire behaviour but ground fires igniting. Marginal.
15/10/1980	0915-1130	13-18	72-90	20-25.8	0-5	Good results.
16/10/1980	0930-1045	12-16	68-82	21.7-28.8	0-5	Too dry. Ground fue ignite.
4/11/1980	0930-1445	11.5-16.5	50-100	19.3-32	0-4	