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SLASH BURNING GUIDELINES

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INTRODUCTION

The results of a preliminary study into disposing of pine slash by fire are presented. The study is far from complete and the fire behaviour results have been obtained from only ten experimental burns. However, they do act as a guide.

RESULTS AND DISCUSSION

1. Quantifying Fuels

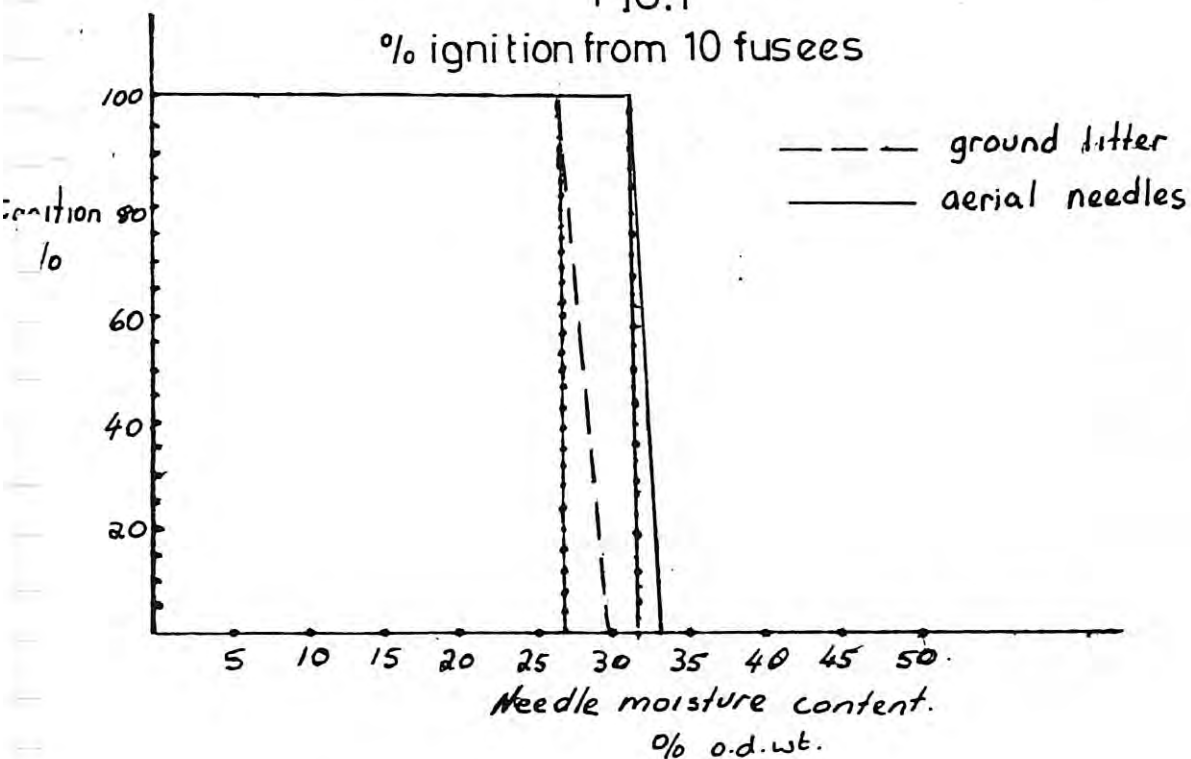
A separate report has been issued on methods for quantifying pine slash (see Appendix 1).

2. Moisture Content and Flammability

Field observations have led to the conclusion that pine needles (in the needlebed) will not sustain ignition when the moisture content of the needles is in excess of 27%. There is quite a clear cut off, as Figure 1 below indicates. Aerial needles will not sustain ignition when the moisture content is greater than 31%. The 4% difference is probably a heat dissipation effect by the solid body of needlebed as opposed to the single needle combustion of the aerial needles.

FIG.1

% ignition from 10 fusees

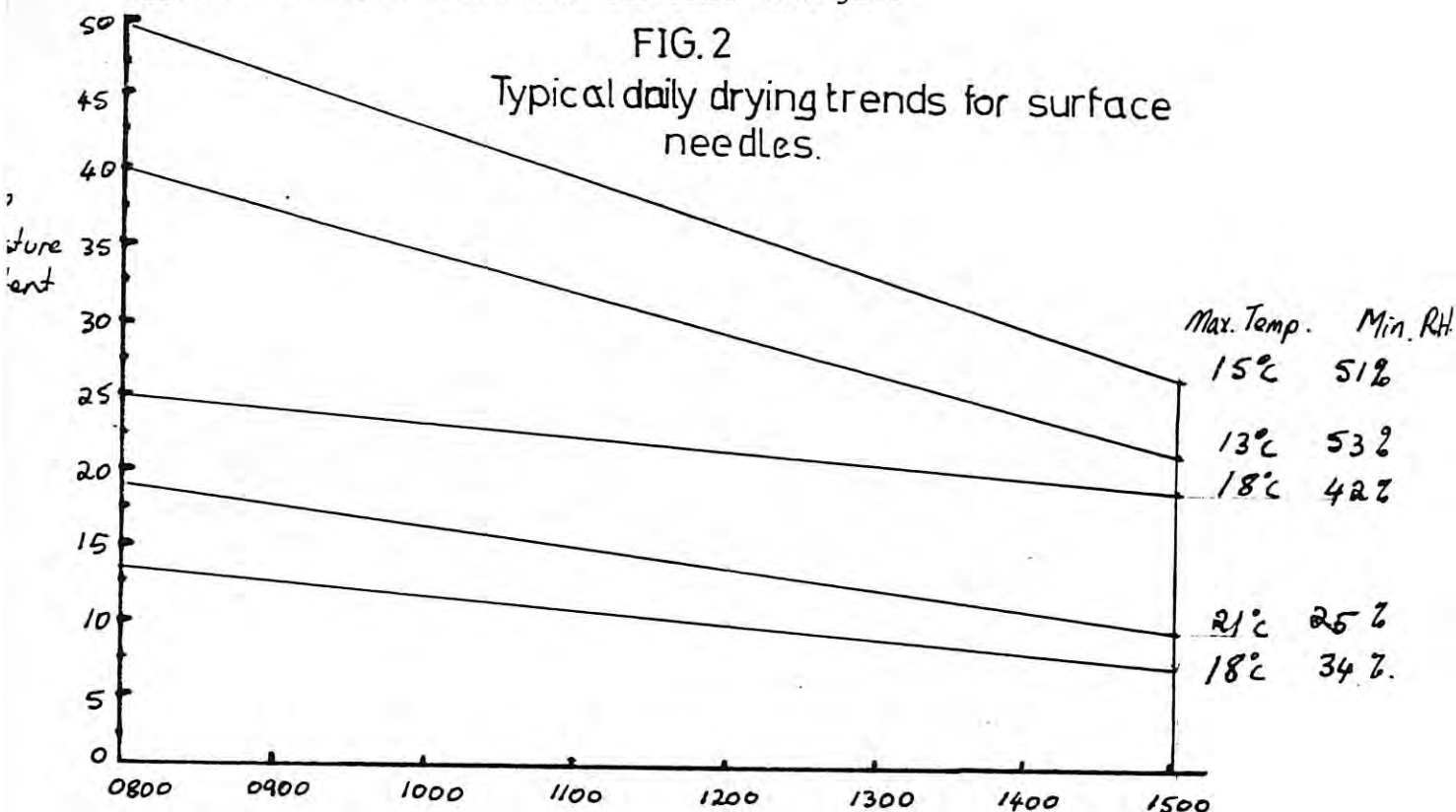


2.1 Drying & Wetting of Fine Fuels (needles)

The SMC table: for pine fuels as per Fire Behaviour Tables was tested against the field situation. It was found that the predicted SMC varied greatly from the actual SMC. The variation was inconsistent and of a magnitude as to be unsuitable.

The prediction tables may be used as a rough guide - field checks at regular intervals ~~are~~ the only means of determining the moisture content of pine fuels.

Pine needles will dry by the hour. The following example is typical of fuel moisture content changes.



The drying trend is of course affected by cloud cover, wind, etc. - The figure does emphasize the rapidity with which ~~Radiata~~ needles dry. Although no data is presented, the needles absorb moisture very readily from the atmosphere so relative humidity is a dominating variable on fuel moisture content.

Aerial needles are more sensitive to wetting and drying than ground fuels because of the greater ~~surface~~ area exposed to the air. Aerial needles will ignite and sustain ignition before surface needles have dried sufficiently to ignite. To predict drying and wetting of fine fuels requires a high variable input. Decisions to burn or not must be based on field measurements of moisture content. Local knowledge or some crude

flammability index is needed to decide whether or not it is worthwhile even sampling the fine fuel moisture content.

Because of the limited number of test fires, a relationship between fire behaviour and the fine fuel flammability has not been determined for surface fuels and aerial fuels.

Available fuel Factor

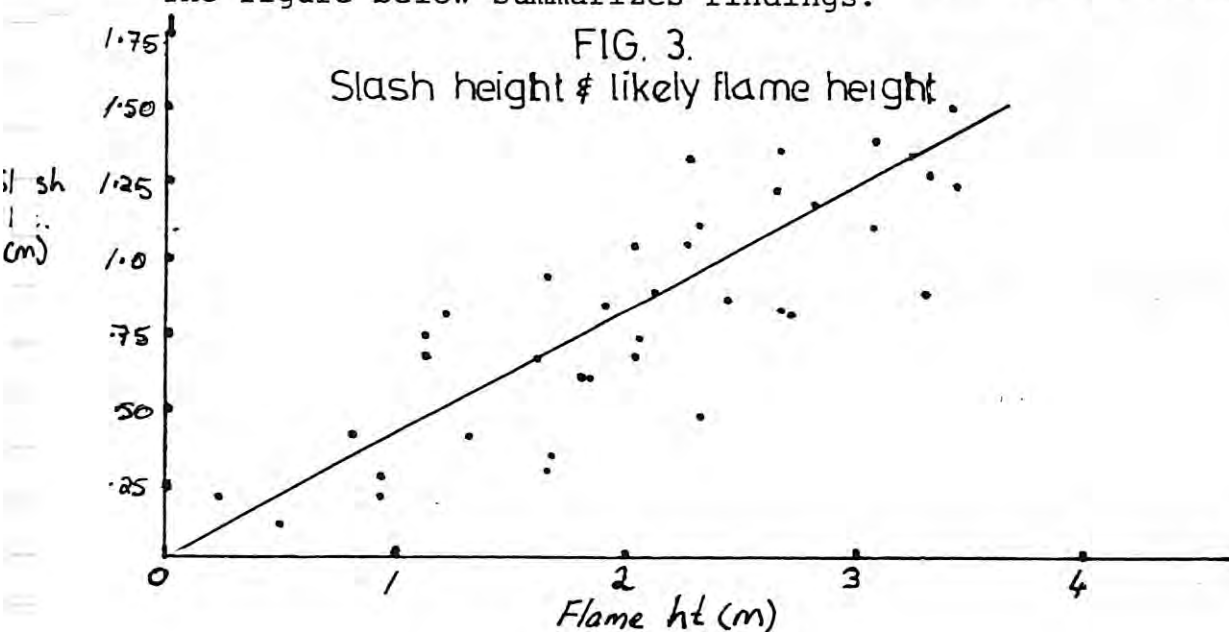
Some 40 pine needlebed burns were studied for needlebed removed by fire. The results were compared to the predicted available fuel (as predicted by the Fire Behaviour Tables) and were within 15% of the predicted figures. There was no strong bias either way so it would appear that the Tables are adequate. When residual tops are added to the fuels, 100% of needles are removed from the tops if the needle moisture content is below 31%. It is the needle component which is most important as this is responsible for flame heights, therefore scorch.

The amount of woody fuel available for consumption is less in a stand which has residual tops. In the clear-felled, heaped situation, the wood available for burning becomes important as this contributes to the fire intensity. In the ten experimental burns undertaken, no fire was intense enough to consume woody fuels greater than 1.5 cm in diameter.

Woody fuel of <1.5 cm diameter and less than 25% moisture content were consumed in the low intensity fires. The available fuel in a residual top then becomes a function of the anticipated intensity of the fire in the needlebed and of the moisture content of the woody component - as well as the fuel distribution.

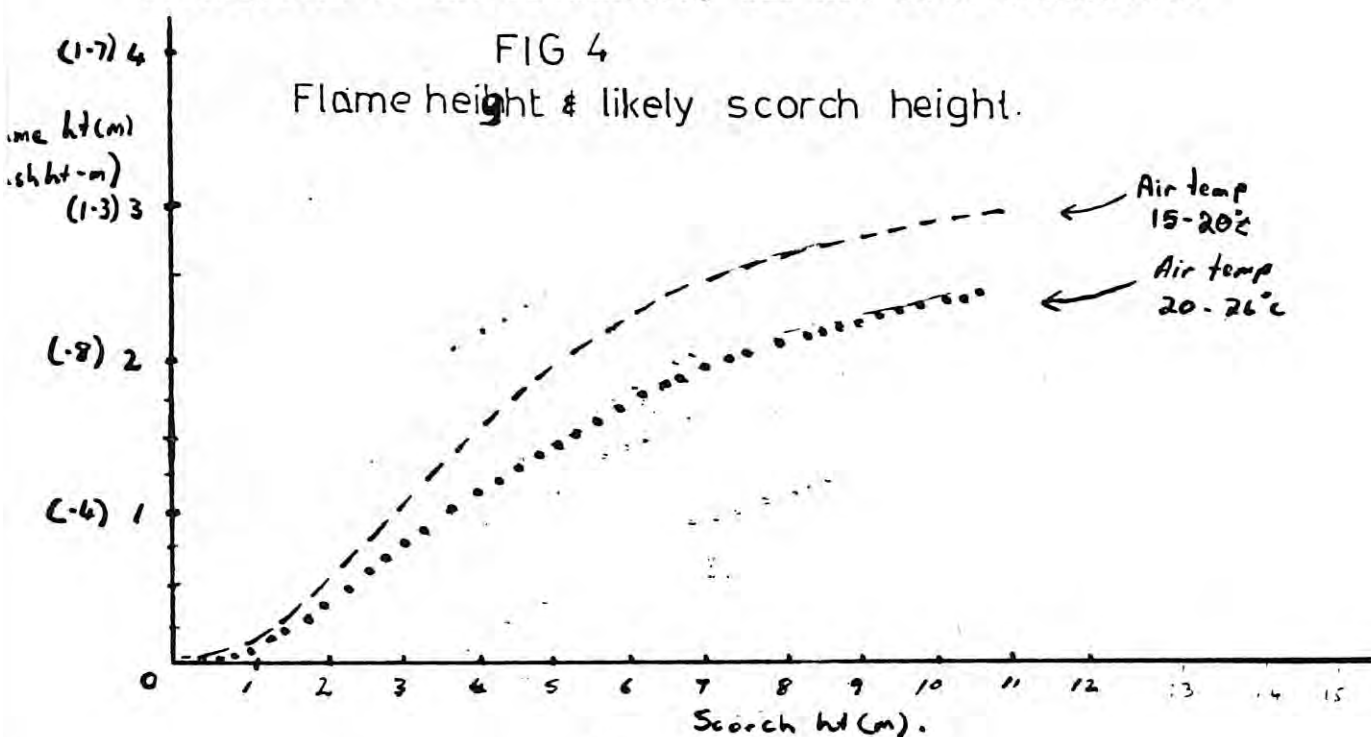
Slash Height, Flame Height and Scorch Height

Flame height will depend largely on slash height, and to a lesser extent, air temperature and the fine fuel moisture content. The figure below summarizes findings.



Wind will also affect flame height. However, very little wind was experienced in any of the ten experimental fires. This was as a result of the sheltering affect within the stand. The quantity of fuel has been unmentioned because this remains very constant for stands logged by the same prescription. The slash height refers to the slash as it is following conventional chain saw thinning technique. Slash which has been crushed into heaps by machine will burn differently.

For a particular air temperature, humidity, and ROS (below canopy wind being 3 KPH) a relationship between flame height and scorch height exists. Because of insufficient replication, the relationship in Figure 2 has been fitted by hand. A mathematical description of the relationship has not been determined.



Further test fires and monitoring are needed to gather sufficient data to enable a greater range of temperatures, relative humidity and fuel moisture contents to be covered. Even so, scorch height can be reduced, for a given flame height, by lower air temperatures.

Burning Season

In an attempt to determine what time of the year P. radiata was least susceptible to fire, a number of small scale experiments were carried out.

One such study examined the affect on the tree, of killing the feeder roots. The feeder roots to a soil depth of 1cm were killed by exposing the soil and blasting hot air over the roots. Twenty P. radiata (11 year old) were treated in early April on an SDI of 1370 (550). To date, none of the trees are showing any ill effects visually or growth wise. This is in keeping with Heyward (1974) who found that a very hot fire in Gorgia killed all pine

feeder roots to a depth of one inch. This did little to harm the trees and he claimed that the feeder roots quickly regenerated.

Although this study has not been completed, it appears that the killing of pine surface feeder roots in autumn has little affect on the tree. It is highly likely that the same can be said for a spring kill.

Needles are far more sensitive to heat than are the feeder roots. Heyward learnt that Montrey pine needles are killed by two minutes of 130°C heat.

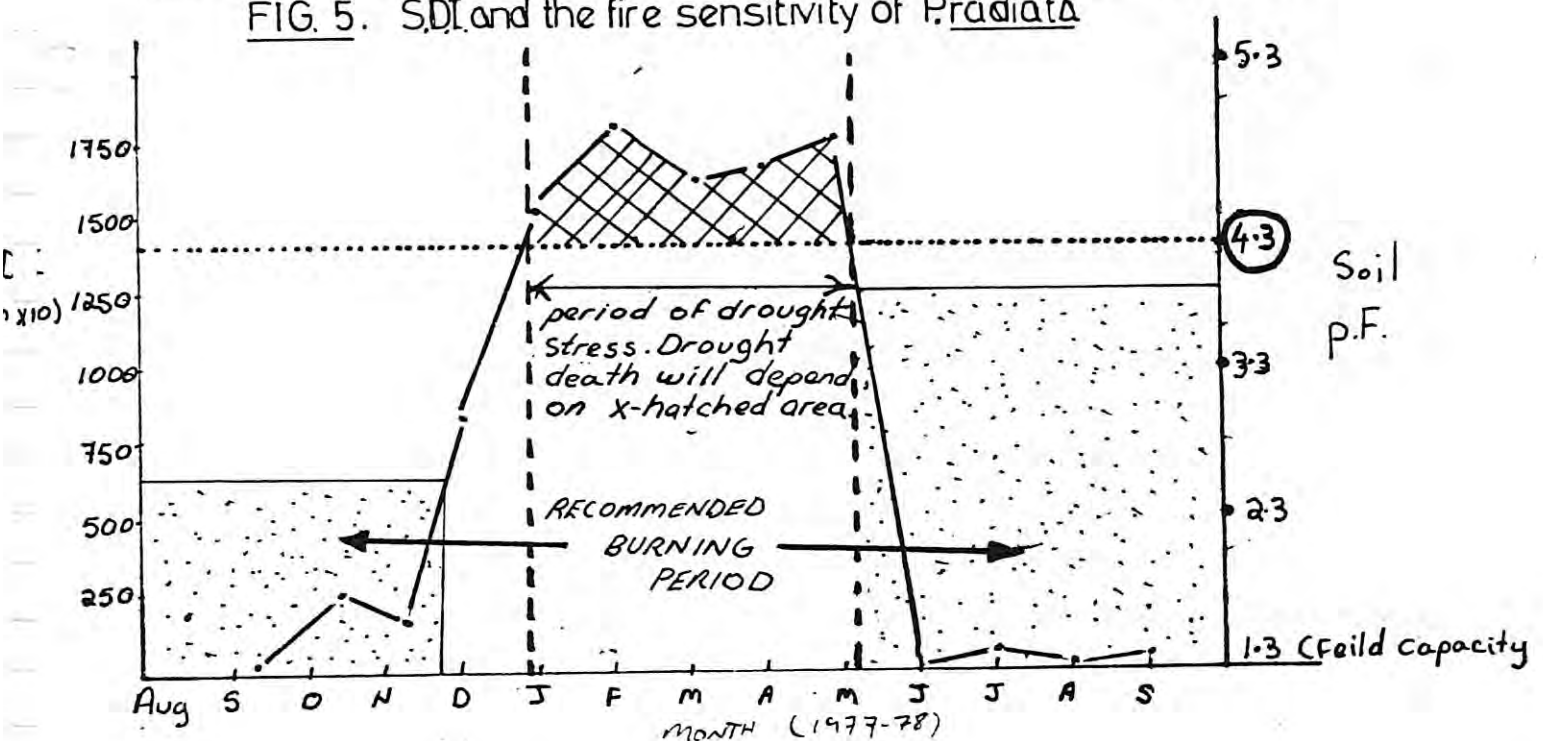
A study to determine the effect of droughting on pine fire susceptibility was examined. From well documented evidence, *P. radiata* is under drought stress when the soil pf exceeds 4.3. By monitoring soils, this was found to occur at SDI 1300 (520 imperial measure) which was December 9 (for 1977/78). Sampling needles from various positions of the tree and determining needle relative turgidity failed to confirm any droughting.

Workers in South Australia have found ^{The same}. The theory being that the transpiration rate is drastically reduced and needles take moisture from the wood cells - the roots being unable to take up moisture from the soil.

Our studies have found that trees under moisture stress (i.e. SDI 1300 (500 points)) do not recover from scorch so readily and are far more prone to dry-siding. Because of the limited experiments, there is insufficient data to quantify scorch recovery and droughting, likewise drysiding. It is also noticeable that trees under drought stress are far more susceptible to attack by blue stain fungus. Again, there is insufficient evidence to quantify the droughting stage of susceptibility.

The following has been constructed from the few experiments which have been conducted in Lewana and Grimwade plantations.

FIG. 5. SDI and the fire sensitivity of *P. radiata*



It would appear from initial observations, that P. radiata is best burnt in autumn, on a falling SDI below 1300. This does not hold if the burn is of such an intensity as to cause less than 40% crown scorch and no cambial damage or bark fissuring (allowing the entrance of 2 lps).

Other possibilities which need examination include burning in spring at least four weeks prior to the SDI reaching 1300 (530). From past years, this means burning before November 21st (or on a SDI < 670 (270)). From limited observations, there is a delay of 3-4 weeks between soil moisture conditions and above ground (needle) physiological response. If the trees are burnt on an index of 670(270) and rising, then, in most seasons, the trees have about four weeks before they come under moisture stress. This time-lag should be sufficient to allow the trees to recover from scorch or any drying effects of the fire.

In summary and from limited observations, the optimum time for pine burning is when the SDI < 670 (270) in spring and when the SDI is 1300 (530) and falling in autumn.

Fire Behaviour in Tops Disposal Burns

Only a very narrow range of conditions have been studied but the following has emerged from ten test fires in "red" from a commercial thin in a 14 year old stand.

TOPS

Fire	SMC	PMC	*AMC	$\bar{x}$ wind (KPH)	Max. temp. (°C)	RH %	$\bar{x}$ FROS (MPH)	Flame Height Needle Bed (m)	Average height OF TOPS (m)	Flame Ht. IN TOPS (ACTUAL) (m)	Flame Ht. IN TOPS (predicted) (m)	Scorch ht. (m)
1	19	148	16	1.6	14	66	39	0.3	1.0	1.5	2.3	3.5
2	24	112	22	2.0	14	63	40	0.2	0.8	1.5	1.9	3.6
3	17	125	16	2.1	14	58	33	0.1	0.5	1.3	1.2	3.2
4	17	140	16	3.8	16	58	50	0.1	1.2	2.0	3	5.1
5	18	55	17	2.6	14	60	50	0.1	1.0	1.5	2.3	3.5
6	16	65	14	2.7	20	32	70	0.4	1.7	2.5	4.0	7.0
7	18	32	17	2.7	19	42	42	0.2	1.0	1.5	2.3	3.5
+ 8	18	32	17	2.9	19	44	10	0.05	0.3	0.8	1.7	2.0
+ 9	18	35	15	2.7	18	45	20	0.08	0.3	0.8	1.7	2.0
+ 10	19	30	16	2.4	17	50	15	0.08	0.3	0.8	1.7	2.0

+ Fires 8, 9 & 10 - very light and broken fuels.

* AMC - aerial moisture content - aerial needles.

The fuels in all plots were very similar.

- i.e. .aerial needles - 8.6 tonnes/ha.
- .wood < 2.5cm diameter - 12.7 tonnes/ha.
- .stemwood > 2.5cm diameter - 27.4 tonnes/ha.
- .needlebed - 9.6 tonnes/ha.

Total fuels: 58.3 tonnes/ha.

Available fuels: 8.6 tonnes/ha (aerial needles)
3.0 tonnes/ha needlebed
(variable-depending on PMC)
4.0 tonnes/ha light branchwood

TOTAL 15.6 tonnes/ha.

In all fires, the consumption of stemwood and branchwood was negligible.

The flame height in all cases varied with the height of slash, as in Figure 2. ROS also varied. For continuous fuels of slash, the forward ROS was approximately double that of the needlebed and broken slash fuels.

All fires were formed under cool conditions and, in terms of fuel removal and damage to the stand, could be considered ideal burns. Conditions such as these occur on about 10 - 15 days in any one year, the remainder being too wet or too hot and dry. Night burning may be one answer.

CONCLUSIONS

Fuel and weather conditions considered to be ideal for tops disposal burns are summarized (the upper limit has not been determined).

SMC	PMC	AMC	TEMP.	RH (%)	WINDS (KPH) at 1.0m	ROS m/s	Flame height m	SDI
15-24	35-140	10-24	14-22	30-60	0-3	10-50	5-20	2670↑ 1300↓

From the data collected, it is possible to dispose of pine residual tops by burning under the conditions outline. Considering the time of the year constraints and fire behaviour constraints, broadscale burning to reduce the slash hazard appears very much undesirable. Further research into night burning may find this an alternative.

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