TIMBER STAN
000445

QUANTIFYING P. RADIATA FLASH FUELS RESULTING FROM ~~T.S.I.~~ OPERATIONS

N. D. BURROWS 1979

000445

INTRODUCTION:

Most timber stand improvement operations in pine plantations result in considerable fuel level buildup. Where a stand has been thinned either commercially ~~as~~ to waste, residual tops, and in particular the aerial nature of the needles on these tops poses a fire threat to the stand. The presence or absence of these tops is not a sufficient classification system to predict the fire hazard within the stand due to these tops. It would appear that on various sites, with various thinning intensities, locations etc. a variety of hazards due to tops, exists. These may range from mild scorch to total destruction ~~situations~~ if fired. Therefore, to gauge the hazard, ~~it would appear obvious that~~ a means of quantifying the fuels (in this case the flash fuel component) ~~is a starting point~~. This study has been directed to that end.

AIM:

To develope a pratical, accurate and simple means of assessing flashy fuels, namely aerial needles in tops of 11 year old P. radiata. This material was chosen for the study for a number of reasons:

a) According to prescription '70, such stands undergo quite heavy thinning.

b) Stands of this age appear most susceptable to fire when both the amount of fuel available and the biological age of the trees is considered. This work looked for a relationship between butt diameter of tops and needle biomass.

METHOD:

5-6 Year Old Prunings:

Samples for this exercise were taken from the Folly Plantation (sections D4 and D5), Nannup. Sampling was at first stratified into midslope and gully sites as there was a visually obvious difference in site qualities. On both sites sample plots of 20m x 5m (0.5 ha) were established some 20m from the plantation edge. The long axis of the quadrates ran perpendicular to the contours. Both sites had been managed on a "Prescription '70" basis, therefore, a "Prescription '70" prune was carried out on both plots. That is, 750.5/ha pruned to 2m. For the purpose of this exercise, only 40 stems from the $\frac{1}{2}$ ha sample plot, were pruned to 2m. Every 2nd stem was pruned until 40 stems had been pruned. The pruned material was bagged (1bag/tree) and returned for analysis. This consisted of, for each branch, taking a butt diameter reading, measuring the length of the branch to the growing tip and stripping the needles from the branch to find their green weight. A sample of these needles was then oven dried to determine the oven dry weight of the needles for each branch. The woody material of each branch was also oven dried and weighed. Both wood and needle material was dried at 85°C.

11 Year Old Tops:

Sampling was stratified into site qualities ~~as determined~~ by Working Plans Officers, based on mean top heights. Because of the insignificance in terms of area of stratums 1+ and 3, sampling was limited to the large tracts of stratums 1 and 2. The following table summarizes the sampling precedure.

.../2

LOCATION	SITE QUALITY	NO. OF ESTIMATES
Lewana B1	1	5
Lewana B6	1	5
Lewana B3	2	10
Grimwade K11	1	6
Grimwade K12	1	5
Grimwade K14	2	5
Grimwade N1	2	6
Grimwade N7	2	5
Kirup "A"	1	8
		TOTAL 55

The above sampling intensity was decided upon following preliminary sampling to determine variation, then using the relationship:

$$N = \frac{(\bar{X})^2}{S\bar{x}}$$

where N = number of estimates
$\bar{X}$ = mean
Sx = standard error

A standard error of 15% was chosen. From this relationship it was determined that approximately 21 estimates from stratum 1 and 25 estimates from stratum 2 were required. The actual number of estimates was 29 and 26 for stratums 1 and 2 respectively.

Areas within strata where chosen for representativeness and access. Sampling was commenced approximately 20m from the edge of the compartment, thus, no edge trees were sampled. Where planting lines were across contours the sample line followed the planting line for half the sample then followed the adjacent planting line to complete the sample. A number of times "point" sampling was used. That is, from a randomly located point in the stand, X number of the nearest trees were felled. Trees felled for sampling were those trees deemed unsatisfactory for retention as crop trees. That is, trees were removed as they would have been under an operational prescription '70 thin.

Having felled the desired stem, its bole was marked along the following D.O.B. classes; 12 - 14cm, 10-12cm, 8-10cm and 6-8cm. It was found necessary to classify tops as in operational thins, such top sizes do exist. Production thins at this age call for logs down to a small end diameter of 7.5cm, but due to market conditions and tree defect, this is rarely the case. It was felt that these class ranges would suffice as had they been smaller the top diameter increment rate, more often than not, would not include a whorl of branches, therefore, there would have been no increase in needle biomass. A larger class range would have increased the error in estimating needle biomass for tops falling in the relevant diameter classes.

Having felled the stem all branches were pruned and labelled according to whorl number, diameter class from which it came and the tree from which it came. This system was later modified so as to reduce the work load. The modification consisted of sampling each whorl and noting how many branched made up the whorl. It is felt that this did not detract from required accuracy or precision, but did reduce the work load by 80%.

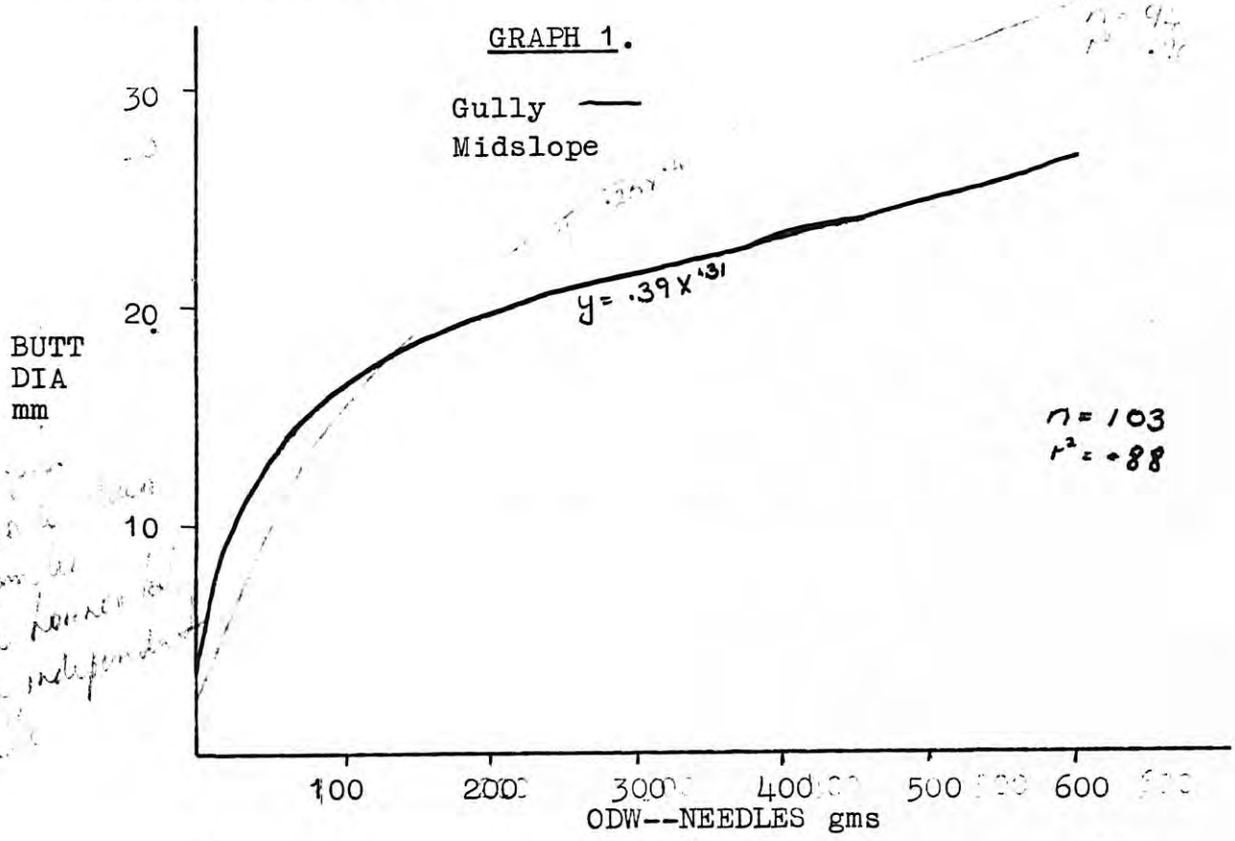
Branch length was measured to the growing tip and branch butt diameter was also measured using calipers. Needles were stripped by hand from each branch and weighed green. This weight was recorded. A sample of these needles was taken and its moisture content determined by oven drying the sample for 24 hours at 85°C. Knowing the moisture content, the oven dry weight of needles per branch was derived.

Thus the end result yielded a branch biomass, a diameter class biomass and finally, a top biomass for tops of various butt diameter. The "woody" component of the top was not considered the interest being only in the flashy, needle component.

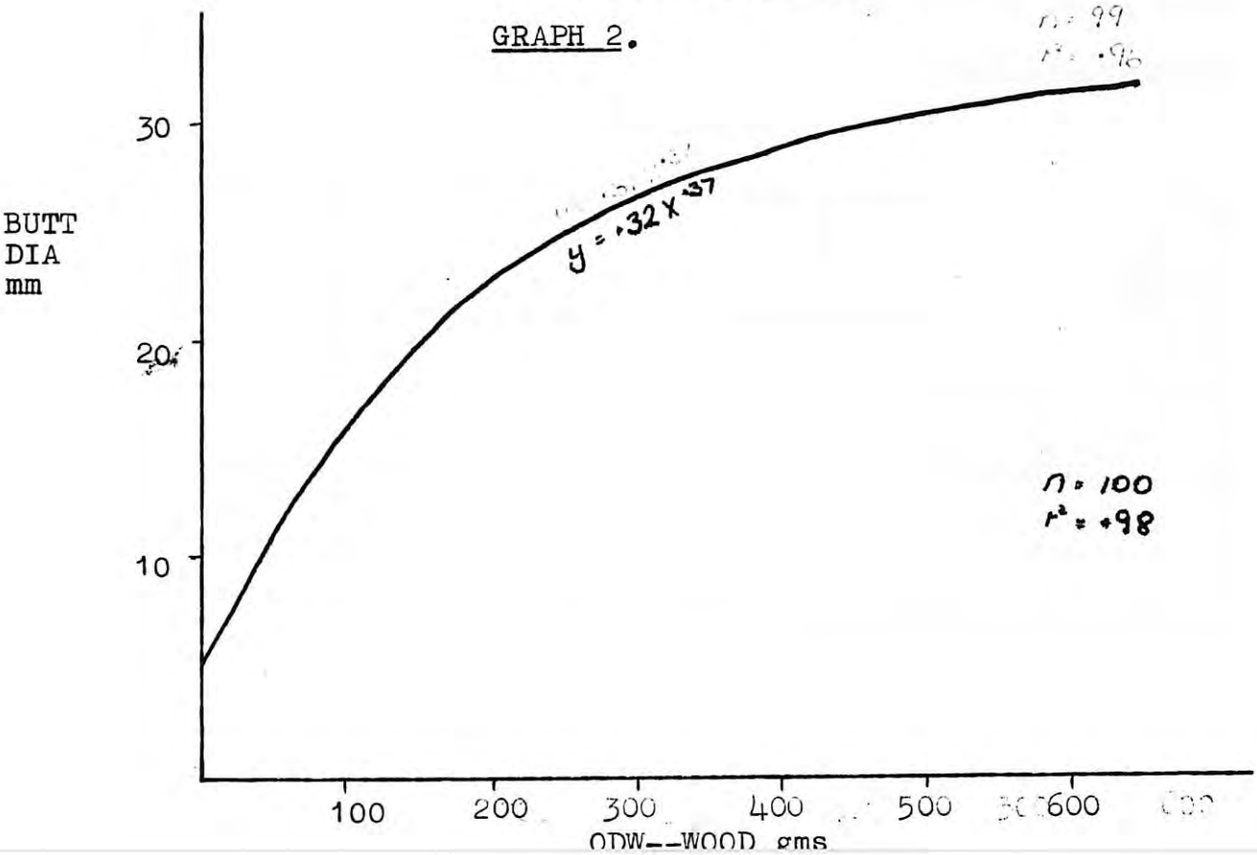
RESULTS:

5 Year Old Prunings:

GRAPH 1.



GRAPH 2.



DISCUSSION OF RESULTS:

From graph 1, it is clear that a strong relationship between branch and butt diameter and oven dry weight of needles exists. The graph also displays the effect of canopy closure on needle abscission of lower branches. It is evident that the gully site stems have been affected by canopy closure. Needles on the lower whorls or the larger diameter branches are not as prolific as on the same site branches from trees occupying the midslopes. The better site quality is reflected in the much more luxuriant needle growth displayed by upper branches of gully site trees. The midslope trees have not yet been affected by canopy closure.

Graph 2 displays a very strong relationship between branch butt diameter and branch oven dry wood weight for both sites as can be seen, the relationship for both sites is almost identical, which indicates that interaction between trees on the two sites has not been a factor affecting growth of wood in branches. However, graph 1 would suggest that this phenomena is just occuring in the gully site. In a very short time, lower whorl branches will cease to function as part of the photosynthesising organ of the tree. Therefore it would not be correct to measure the amount of added fuel following a pruning operation by measuring the branch butt diameters alone. The relationship between branch butt diameter and branch biomass is strongly influenced by canopy cover and interaction with other stems. For a given planting spacing, this is site factor. Where canopy closure is not yet a parameter to be considered, then for a given age stand on given site conditions there is a strong correlation between branch diameter and branch biomass. This correlation may have not been so strong had the sample covered a wider range of site conditions.

Such information is of little value as a means of fuel measurement for burning largely because it would be unwise to control burn in 5 year old pine in most instances. However, it does give an indication of the amount and type of fuel added following a pruning operation, ~~which surely, is an advance on not knowing.~~ For example, if 750 midslope stems are pruned to 2m, it can be calculated that approximately 1215 Kg/Ha of needles and 1687 Kg/Ha of woody material has been added to the fuel level of the stand.

11 Year Old Tops;

KIRUP "A".

DIA CLASS (cm)	6-8	8-10	10-12	12-14
N	8	8	8	8
$\bar{X}$ (Kg)	2.17	4.19	5.70	8.44
S.D.	.43	1.00	1.14	1.35
C.V. %	19.98	24.40	20.50	16.98

..5/

#J 63

TOTAL STRATUM 1.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	26	28	28	29
$\bar{X}$ (Kg)	2.22	3.75	5.68	8.19
S.D.	.52	.86	1.19	1.11
C.V. %	23.26	22.93	20.19	13.55

TOTAL STRATUM 2.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	28	28	27	26
$\bar{X}$ (Kg)	1.89	2.20	5.30	7.65
S.D.	.43	.75	.80	1.19
C.V. %	22.7	23.44	15.09	16.91

GRIMWADE - STRATUM 1.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	11	11	11	11
$\bar{X}$ (Kg)	1.91	3.37	5.57	7.90
S.D.	0.61	.90	1.00	1.34
C.V. %	32.51	27.44	18.45	17.75

...6/

E/64

GRIMWADE - STRATUM 2.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	16	15	16	15
$\bar{X}$ (Kg)	1.78	3.43	5.37	7.38
S.D.	.55	1.02	1.28	1.47
C.V. %	31.42	30.11	24.63	20.79

LEWANA - STRATUM 1.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	10	10	10	10
$\bar{X}$ (Kg)	2.48	4.14	5.85	7.31
S.D.	0.71	0.61	0.77	1.31
C.V. %	28.62	14.74	13.16	17.92

LEWANA - STRATUM 2.

DIA. CLASS (cm)	6-8	8-10	10-12	12-14
N	10	10	10	10
$\bar{X}$ (Kg)	2.40	3.85	5.44	6.91
S.D.	0.61	0.56	0.64	1.10
C.V. %	25.4	14.54	11.76	16.00

...7/

The tables ~~previous~~ are self explanatory. It should be mentioned that at the 95% level, there was ~~found to be~~ no significant difference between the means of each stratum in all diameter classes. Considering the nature of the population it would seem reasonable to accept the standard errors in the tables. It is noticeable that the standard error tends to be greatest in the smaller diameter classes. This could possibly be due to the fact, that this top section is primarily growing tip which will amplify differences in site quality, dominance status and provenances. Also growing tips are susceptable to damage by abrasions with other tops or from parrots etc.

It would have been desirable to intensify sampling but lack of equipment made the processing of tops time consuming and arduous, ~~thus~~ the restricted sample size.

Unlike the 5 year old material, no relationship could be established between branch diameter and o.d.w. of needles. Also, the relationship between branch length and o.w.d. needles was comparatively weak. It was found that for o.w.d. needles (Kg) Y and branch length X(mm).

$$Y = 0.09X - 0.03$$

With a correlation co-efficient of .43. This does not concurr with McCormick (1973) who developed a method for calculating P. pinaster thinning residue. McCormick's work was based on a relationship between the o.w.d. of needles, and twigs unit length of branch and the total branch length for one crown. Total branch length was related to the butt girth of the crown so that by measuring a number of butt girths, the weight of needles and twigs on the lopped crown could be evaluated. McCormick found 193g of needles for every metre of crown branch. The author found a very strong trend for branches of the bole between 14 an 10cm d.o.b. to be very sparsely foliaged. Very often, especially in the 12-14 cm diameter class, these branches were very long (up to 3m) yet only supported tufts of small, soft needles. This is probably due to theshadowing of these branches by other trees and by branches overhead. With decreasing diameter, this feature also decreased. It was found that a significant proportion of the needle weight is carried on the stem itself, especially in the last 2 years growth regions. Needles in this section accounted for, on average, 9.4% of the total needle o.d.wt. for a top of between 10-12cm d.o.b. This proportion increased with decreasing top butt diameter. It was also very obvious that branches higher up in the crown, (lying between 8cm d.o.b. and growing tip) though not very long in comparison to branches lower down the bole, supported a generous load of succulent needles. McCormick found that, for P. pinaster, the total crown branch length in metres (Y) to be related to butt girth diameter (X) by:

$$Y = 0.217X - 24.254$$

This gave a co-efficient of determination of 0.77.
For P. radiata the above relationship was found not to be strong.

$$Y = 0.72X - 27.78$$

This relationship gave a corelation co-efficient of 0.55. This poor corelation would largely be due to the above mentioned factors.

...8/

SUMMARY:

The results of this research will mean that 11 year old P radiata tops can be quantified with reasonable cost and with relative ease. By line sampling, the aeriel fuels in tops can quickly be assessed. All stems intercepted by the line have their diameters recored. Knowing the total number of tops per ha, it is then a simple matter of claculating the weight of tops flash fuel by relative proportion. It has yet to be determined whether this method is sufficiently accurate. This can only be confirmed by experimental fires. The next step then, is to test whether this means of top assessment is not so erroreous as to lead to significantly varied fire behaviour for the same calculated fuel quantities, other things being equal.

This quantitive measure alone is of limited value. The inflamability of the tops will depend on moisture content and the chemical composition of the tops. It would appear that, with changes in colour, the needles are undergoing some form of chemical change. It is quite possible that each colour - chemical change will differ in inflammability. For instance, it is well known that red needles are quite volative, but how much more so than green, yellow or grey needles, is not known. Therefore, it is important to know not only the biomass of the tops, but also their combustability status. In view of this a colour photo series of tops is being established. By use of colour photographs changes in top colour are being monitored. With changes in needle colour, needle drop is also being measured. Through experimentation it is hoped that top colour can be fairly accurately given a combustability rating. As the quantity of aeriel fuel is impartentant it is possible that needle colour will also be an indicator of the extent of aeriel fuel becoming ground fuel.

CONCLUSION:

Before any steps can be taken to manage fuels under pines especially tops, it is most important to understand the relationship between fire behaviours and the "flash" fuels of tops, other things being equal. To aid in the developement of such a relationship, and accurate, simple method of measuring tops is a basic requisite. Such a method is presented in this paper. Unfortunately, the results of this work can not be guaranteed to be of use for other than 11 year old P. radiata under "Prescription '70" management. A small sample of a 12 year old P. radiata stand showed no significant difference in top biomass so it is possible that this method may be flexible.

Neil Burrows
ADFO.