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THE VH MULCHER - SPOT CULTIVATOR - MOUNDER FOR SITE PREPARATION

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Figure 1 - VH Mulcher mounted on Cat 320L working in heavy slash

ABSTRACT

The VH Mulcher spot cultivator-mounder was studied to assess its productivity and site effects. It was working in heavy slash under wet conditions on moderate to steep slopes. It was preparing spot mounds for replanting a recently harvested site. The machine was producing mounds with an average height of 23 cm. The stocking of the spots produced varied, from 800 to 1200 spots per hectare, around a target of 1000 spots per hectare. The cost of the operation at the target stocking of 1000 spots per hectare was estimated to be $670 per hectare. The number of spots per hectare heavily influenced the cost of the operation. An assessment of the site found 96% of the spots to be within specification but the stocking was not.

INTRODUCTION

In recent years, forest companies have been re-examining their re-establishment and mechanical site preparation operations with the intention of improving the quality of the end result whilst reducing site impacts. The changes that have been made in many cases have been to move away from burning and intensive bulldozer-based operations to excavator-based operations and spot treatments.

Some forest companies and site preparation contractors have taken the next step, developing site preparation operations that leave the logging residue (and the nutrients therein) as widely spread over the cutover as possible whilst still creating a good planting site. This can be achieved with spot slash treatment and soil cultivation.

There are a number of attachments available for excavator-based spot site preparation. In 1995, a contractor in the South Island (Peter Kealy, Fairlie) imported two VH Mulchers from Canada. In July 1996, LIRO conducted a production study and site assessment on one of these machines working in Otago Coast Forest (Wenita Forest Products Limited), near Dunedin. The results of these studies are presented in this report.

The study was a preliminary evaluation of the machine to highlight potential benefits and costs of its utilisation.

VH MULCHER

The VH Mulcher consists of a hydraulically powered rotary disc cultivation head with large teeth attached to the cultivation tines. The head weighs approximately 1.8 tonnes and is 1.2 m in diameter. The VH Mulcher was mounted on a Cat 320L excavator with modified tracks. The cost of the VH Mulcher was estimated at $35,000 ex factory in Canada. This does not include the cost of fitting it to the excavator base, or other modifications to the excavator. The all-up cost of the mulcher and excavator was estimated at $400,000. The VH Mulcher can be quickly detached from the excavator, allowing it to be used for other operations.

The cultivator head works in the following way. The planting spot is cleared of slash, the head is extended away from the excavator and the cultivator tines are rotated as they are pushed into the ground and pulled toward the excavator. The head is tilted as it is pulled toward the excavator. The soil collected in the cultivator head is dropped in the mound when it is lifted from the soil at the end of the action. The soil profile in the cultivated area is changed substantially, with the litter, topsoil and subsoil layers all mixed together.

In Figure 1, the teeth used for pushing aside the slash can be seen at the front of the VH Mulcher (on the right of the machine). At the rear of the Mulcher (on the left), there is a hydraulic thumb that can be used to grasp large items of debris or piles of slash and "windrow" them. A hydraulic thumb such as this would be of benefit, and could be fitted, to any excavator working in site preparation or roading operations. It would be particularly helpful in windrowing, stream clearing, and landing debris retrieval operations.

ACKNOWLEDGMENTS

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SITE DESCRIPTION

The soil type on the trial site was Akatore hill soils, grey brown silt loam (15 cm) over brown yellow silt loam (15 to 60 cm) over weathered greywacke (Kennedy, 1983). During the study both the weather

and soil conditions were wet. The site had two slope classes - 60% of the site was 5º to 15º and 40% of the site 15º to 25º.

The number of stumps per hectare was 170 (range 150 to 200).

METHODS

The trial site (2 hectares) was assessed prior to treatment for soil disturbance (McMahon, 1995), soil shear strength and slash volume (Hall, 1996).

The operation was then time studied using activity sampling (Brisley, 1971) for a total of seven hours.

Two work methods were used by the VH Mulcher during the study. In the first, the rows of spots were created perpendicular to the direction the excavator travelled in and, in the second, the rows were parallel to the direction of travel.

After the site had been treated, it was reassessed for soil disturbance, soil shear strength in the mounds, mound heights, mound quality and spacing.

The prescription for the site was a 25 cm mound over cultivation to 50 cm at a stocking of 1000 spots per hectare (5 m by 2 m).

RESULTS AND DISCUSSION

Slash Volumes

The pre-treatment slash cover was estimated at 88 m^3/ha, (Table 1). The treatment of the site did not change the slash volume. It re-distributed it and broke some of the pieces into smaller lengths.

The site was easier to walk over after the treatment, due to the excavator's tracks crushing some of the slash.

Table 1 - Stem branch and total slash volumes

Stem wood	Branch	Total*
28 m^3/ha	60 m^3/ha	88 m^3/ha

PLE = 14.4% (95% confident limit, 75 to 101 m^3/ha)

Ground cover

Prior to treatment, 59% of the site had a layer of slash, 41% of the site had the ground visible.

There was no standing vegetation and no significant weed growth on the site.

After treatment, 47% of the site was covered in slash, 53% had the soil visible. There was still a substantial area of the site covered with slash even though this area was reduced from the pre-treatment level.

The slash layer caused "heavy hindrance" for walking across the site prior to treatment. The passage of the excavator reduced walk hindrance to "moderate".

The spots created were clearly visible and planters should have had no difficulty locating all spots for planting.

Soil disturbance

The major change in pre and post-treatment soil disturbance was due to the creation of the mounds. Undisturbed and lightly disturbed areas were reduced and deep disturbance decreased (Table 2). If mounds are classified as deep disturbance then deep disturbance increased.

Table 2 - Pre- and post-treatment soil disturbance levels ± absolute error

	Pre - treatment (n=703)	Post - treatment (n=686)
Undisturbed	29% ± 3.4	16 % ± 3
Shallow disturbance	47% ± 3.7	34 % ± 4
Deep disturbance	24% ± 2.1	22 % ± 2
Spot Mound	0	28 % ± 3

Production Study

The study duration was 7.23 hours during which 1.17 hectares were treated. The production rate was 0.16 hectares per hour or 6.25 hours per hectare. At a cost of $130/machine hour the cost was $812 per hectare (Riddle, 1994).

The work pattern used first was to create rows of spots perpendicular to the direction the excavator was travelling in and to create 5 to 7 spots from each point (Figure 2). The average spacing put in with this method was 4.1 m (± 1.2 m) by 2 m (± 0.5 m) or (1220 spots per hectare). This was overstocking of 22 %.

The rate at which spots were being created was 3.25 spots per minute. If the correct stocking had been put in at this speed, the time taken would have been 5.13 hours at a cost of $670/hectare. This highlights the need for careful and regular checking of the spot spacing, as the overstocking of a site will have a substantial effect on the cost of the operation.

The second work pattern was where rows of spots were made parallel with the direction of travel and making three spots from each point.

Using the second method, the amount of time spent moving, slewing and windrowing heavy slash increased, whilst the amount of time spent making mounds decreased. However, although the number of spots per minute created was slightly lower at three spots per minute, the rate of production in terms of area covered was higher. The lower cost using the second method was a result of wider spacing and lower stocking of the spots. The spacing using the second method was 5 m by 2.5m, or 800 spots per hectare (target, 5 m by 2 m at 1000 spots per hectare). This was understocking by 20 %.

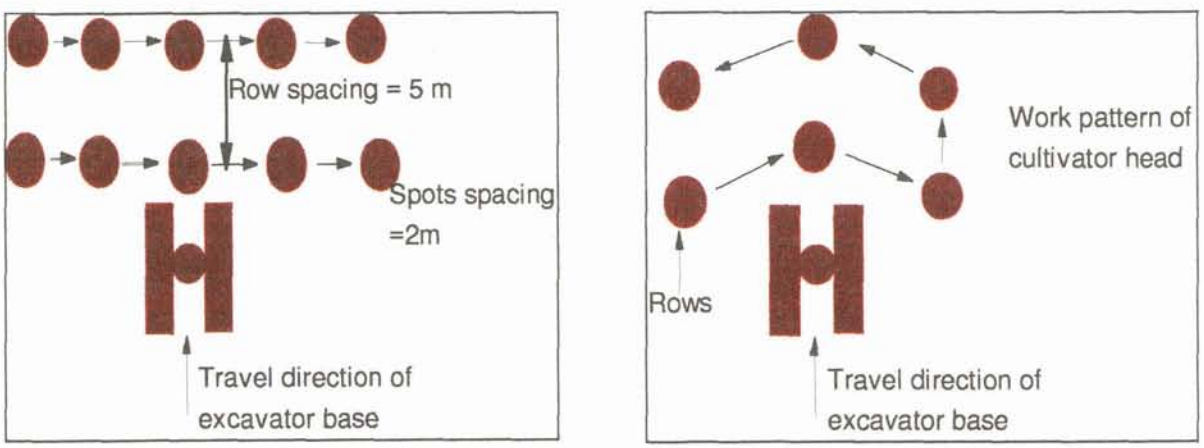

Figure 2 - Machine work patterns, first work pattern on left, second work pattern on right

The conditions during the study were quite difficult with short runs between turns, steep gully sides, wet soils and heavy slash. The number of spots created per minute will be affected by all these factors.

The rate of production observed using the first study, 3.25 spots per minute, should be able to be reproduced on many sites, excluding those which are steep (> 25°), wet or have rock at a shallow depth (< 50 cm). Under better conditions, the rate of production would rise. Table 3 gives a range of per hectare costs based on varying stockings and production rates, using a cost of $130 per machine hour.

The stocking had a substantial effect on the cost. Getting the stocking on target is crucial to lowering per hectare costs. The shaded area in Table 3 highlights the range of production rates, stocking levels and costs that are likely to be typical. The rates of spot production for other excavator spot cultivators (Hall 1995, Hall 1997) are between 2.5 and 4.6 spots per minute. The use of regular spacing checks was a feature of these operations.

Whilst these costs may appear high, excavator-based operations are the only option available for mechanical site preparation on slopes in excess of 15° to 20°.

Production and cost of the operation will be affected by the reliability and availability of the machine. This study was not of sufficient duration to determine the availability of the machine.

Quality

The quality of the spots created was assessed (n = 224): 96% met the specification (215), 4% were rejected (9). Of the spots rejected, 78% (7) were because of slash in the mounds that was too heavy to remove or plant through and 22% (2) for insufficient (less than 25 cm) or no mound.

Average mound height was found to be 29 cm (±12 cm) immediately after the mounds had been created. However when the mounds were re-assessed one month after the operation they had settled to an average height of 23 cm (± 9 cm).

Soil cultivation

Soil shear strength was measured both in the mounds and in the undisturbed soil (Figure 3). The soil in the mounds had a lower shear strength than the untreated soil to the depth to which the VH Mulcher was effective (50 cm). The root growth of radiata pine is restricted by soil strength levels in excess of 3 MPa (Mason and Cullen, 1986). Mean rooting depth was increased from 20 cm in untreated soil to approximately 50 cm in the mounds. The depth in the mounds was measured from the top of the mound to the bottom of the cultivated soil.

Table 3 - Estimated costs, varying with stocking and production rate

	800 spots/ha	1000 spots/ha	1200 spots/ha
3.0 spots/min	4.4 hours @ $570/ha	5.5 hours @ $715/ha	6.6 hours @ $860/ha
3.25 spots/min	4.1 hours @ $530/ha	5.1 hours @ $665/ha	6.2 hours @ $805/ha
3.5 spots/min	3.8 hours @ $495/ha	4.8 hours @ $625/ha	5.7 hours @ $740/ha
3.75 spots/min	3.6 hours @ $470/ha	4.4 hours @ $570/ha	5.3 hours @ $690/ha
4.0 spots/min	3.3 hours @ $430/ha	4.2 hours @ $545/ha	5.0 hours @ $650/ha

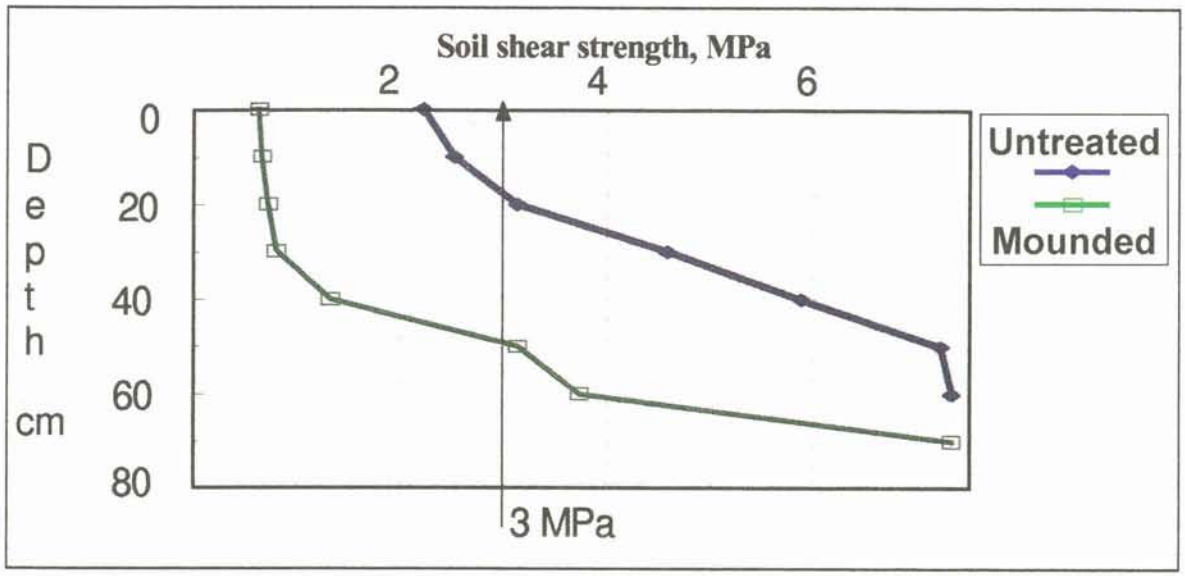

Figure 3 - Soil shear strength, untreated and mounded soils

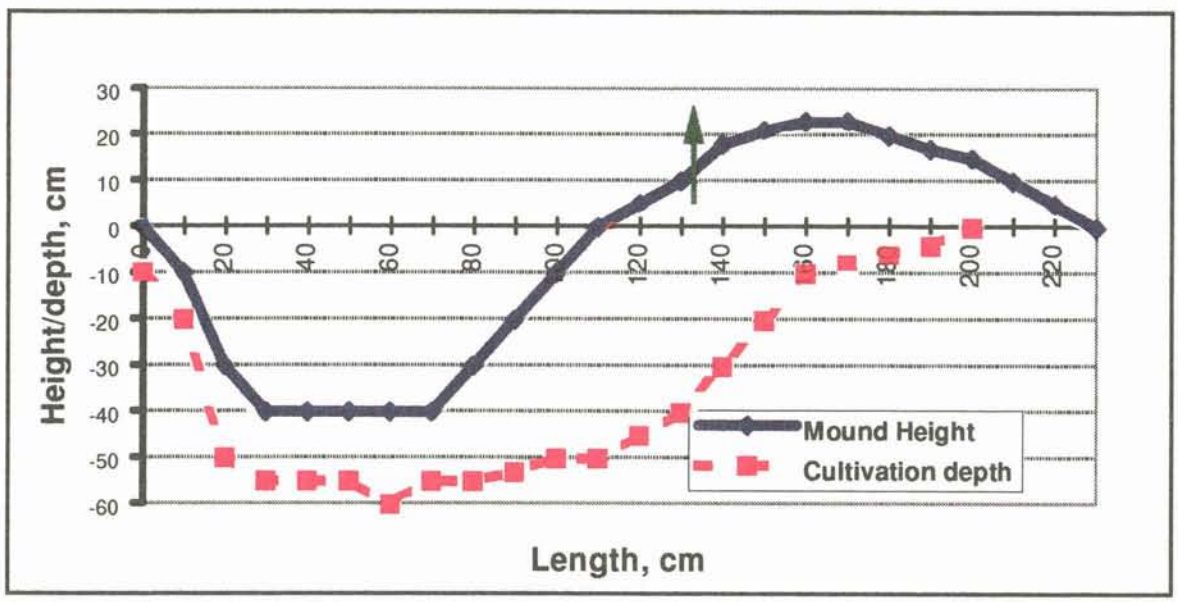

Figure 4 - Profile of mound created by VH Mulcher

A sample of mound profiles (n=10) was measured. A cross-section of an average mound was drawn (Figure 4). The x-axis (horizontal) represents the original ground level. Trees are planted close to the peak of the mound on the side closest to the hole.

The volume of cultivated soil present at each spot was estimated to be 0.4 m^3.

Mounding affected the untreated soil profile as the soil horizons were mixed together with the litter layer.

The effects of the mixing of the soil on early tree growth have not yet been determined for this site as yet.

A growth trial has been established by LIRO in conjunction with Wenita Forest Products Limited in Otago Coast Forest to determine the effects of the VH Mulcher treatment on the growth and root development of radiata pine.

CONCLUSIONS

Production rates were 3 to 3.25 spots per minute.

Production rates and costs were heavily influenced by the number of spots created per hectare and putting in that stocking accurately.

Overstocking increases per hectare costs. Achieving the desired stocking (number of spots per hectare) will require regular monitoring by and of the operator.

The excavator tracks did not cause any increase in rutting (deep soil disturbance).

Disturbance to the site during treatment was confined to the mounds, thereby protecting the remainder of the site.

Quality assessment of the mounds found that 96% were acceptable for planting.

The costs stated in this report have been determined using LIRO costing procedures. They are an indicative estimate and do not necessarily represent the actual costs for this operation.

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