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A double site-preparation treatment to reduce the costs of site conversion for short-rotation plantations

Abstract

FERIC's study examined the potential of intensive site preparation based on a double treatment (brushcutting plus harrowing) as an alternative to expensive mulching techniques for stand conversion. Although the proposed technique did not work the soil as completely as mulching, it significantly decreased treatment costs.

Keywords:

Site preparation, Brushcutting, Harrowing, Short-rotation plantations, Stand conversion, Costs, FAE UMM/S-225 mulcher, New Holland Versatile TV140 tractor, Rotobêche 810 harrow, Lamborghini 165 Racing tractor, Case MX200 tractor.

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Introduction

Intensive site preparation is often required to establish hybrid poplar plantations, which have high demands for light and soil resources (Boysen and Strobl 1991). The techniques available for intensive site preparation are generally expensive and can thus only be applied on a limited scale. Given the magnitude of its new short-rotation plantations program, Domtar Inc.'s forestry resources group in Windsor felt it was vital to identify less-expensive techniques that would make this kind of forestry more economical.

In contrast with the usual situation for reforesting abandoned agricultural fields, the target sites in this study were cutovers less than 10 years old, with deep soils, moderate stoniness, and regeneration dominated by hardwoods. The topography and the presence of stones and stumps under forestry conditions significantly limited the equipment available for intensive treatment of the sites.

Previous studies have demonstrated the potential of forestry mulchers for providing a high-quality treatment, but at high cost (Cormier and Provencher 1997, Cormier 2001). To reduce the treatment costs, we proposed limiting the mulchers strictly to cutting brush and then working the soil using a disc harrow. The objective of the study was thus to verify whether the proposed method would reduce the treatment costs while still providing sufficiently intensive site preparation to meet the needs of hybrid poplar.

Description of the treatment and equipment

The brushcutting was performed by an FAE UMM/S-225 mulcher mounted on a New Holland Versatile TV140 tractor with bidirectional controls that provided 77 kW at the pto (Figure 1). The mulcher was equipped with fixed hammers mounted on a horizontal rotor. Its working width was 2.17 m (maximum width of 2.73 m) and it weighed 2510 kg.

Figure 1. FAE UMM/S-225 mulcher mounted on a New Holland Versatile TV140 tractor.



After brushcutting, the soil was worked with a Rotobêche 810 harrow equipped with 19 disks (81 cm in diameter) arranged in two rows, which provided a working width of 3.25 m. The 4000-kg harrow was pulled by either a Lamborghini 165 Racing tractor (Figure 2) or a Case MX200 tractor, which provided (respectively) 110 and 123 kW at the pto. This part of the treatment consisted of two successive perpendicular passes by the harrow.

Figure 2. A Rotobêche 810 disk harrow pulled by a Lamborghini 165 Racing tractor.



Results

The work took place in Quebec during the summer of 2001 on sites in the Eastern Townships and Beauce regions that had been harvested between 1990 and 1994. In both areas, the soils were loamy, with fresh drainage, high stoniness, a thin humus

layer, and gentle slopes (Table 1). The original stands were dominated by hardwoods, but the Eastern Townships stands had a larger poplar and softwood component.

Brushcutting was more rapid on the Beauce site, though the productivities were similar at both locations for the double pass of the harrow that followed the brushcutting (Table 2). Using the mulcher reduced the stump heights by 53 and 34%, respectively, on the Eastern Townships and Beauce sites. The shorter, less-frequent stumps and the lower proportion of hardwoods on the Beauce site improved the mulcher's productivity. However, the faster treatment and the higher density of brush (compared with the Eastern Townships site) could also have resulted in less complete mulching of the vegetation; that would have interfered with the harrow's subsequent work and resulted in the lower level of disturbance that we observed. The plantability produced by the combined treatment was fairly good even if most of the microsites were considered marginal because planters would only have to provide a minimal additional effort before planting the poplar.

Each treatment and each pass by the harrow improved the quality of the microsites (Figure 3). The second pass by the harrow significantly improved on the work accomplished by the first pass. It would be useful to determine the impact of adding a third pass.

Discussion

Our trials of intensive site preparation for stand conversion demonstrated that a relationship existed between the intensity

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of soil disturbance and the treatment cost (Figure 4). Mulching treatments that incorporate organic matter deeply into the soil provide excellent results, but at a very high cost. The use of lighter equipment reduces the mulching costs, but produces a more superficial incorporation of the organic matter. The use of two successive passes by a forestry harrow without prior brushcutting under conditions with dense brush is considerably less expensive than either option, but the treatment quality leaves something to be desired. The double treatment that combined brushcutting with harrowing in the present study represents a reasonable compromise solution.

Although the production of hybrid poplar generally benefits from the most-intensive preparation of the soil that is possible, the cost of the site preparation remains crucial; given the number of years before harvesting and the effect of compound interest, the initial expenditure will have more than doubled 15 years after the treatment at a 5% interest rate. However, a complete analysis of the system is required because in addition to any growth effects, less-intensive site preparation could increase future tending costs.

Because the technique we studied was in its first year of implementation, certain adjustments could still improve productivity and treatment quality. The mechanical availability of the mulcher was the main problem we observed during the summer. Apart from repairs to the hammers caused by the stoniness of the study sites, several other delays would probably have been avoided if a more powerful tractor had been used to drive the mulcher. Although the mulcher's designers recommend a power of more than 95 kW at the pto for the model used in our study, the Versatile TV140 tractor only provided 77 kW. The Rotobêche harrow also wasn't the best design for the treatment of rough ground. All the harrow's disks are mounted on the device's frame, and because the entire frame is raised by stumps and stones, it

Table 1. Site conditions

	Eastern Townships	Beauce
Brush		
Density (stems/ha)	13 500	24 000
Height (m)	2.4	3.1
Stumps		
Density (number/ha)	473	367
Diameter (cm)	33	23
Height (cm)	34	29
Stoniness (%)	77	76
Humus thickness (cm)	6	8
Coverage of debris on the ground (%)	5	2

Table 2. Productivity and work quality produced by the double treatment

	Eastern Townships	Beauce
Productivity (ha/PMH)		
FAE mulcher	0.47	0.53
Harrow (double pass)	0.49	0.47
Disturbance (% of cover)		
Mixed or exposed soil	35	22
Disturbed humus	37	30
Debris	10	15
Litter	15	30
Stones and stumps	3	3
Plantability (%)		
Good	27	32
Marginal	69	59
Poor	4	9



Figure 3. The increase in disturbance after each pass of the machines.

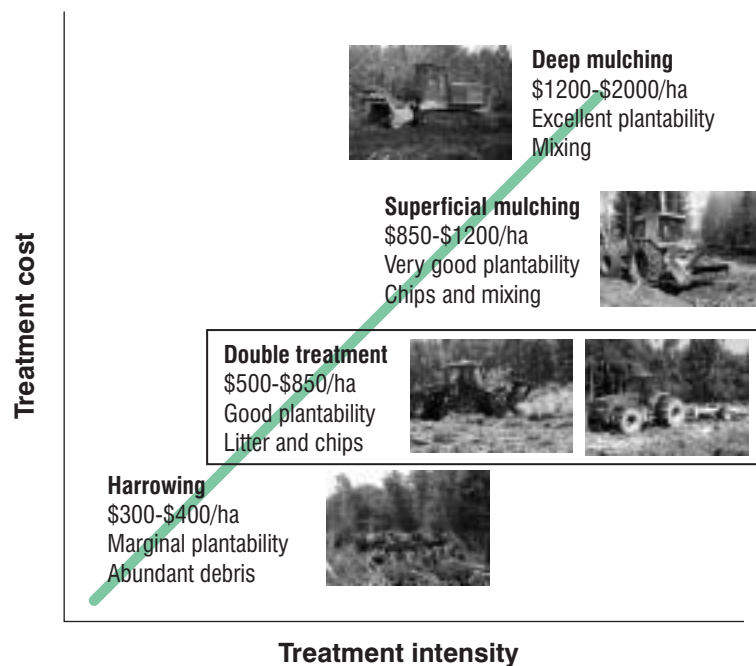


Figure 4. The relationship between treatment intensity and treatment cost for various intensive soil-preparation techniques in stand conversion operations.

becomes difficult for the implement to reach the bottom of depressions. A harrow with independently mounted disks would improve the treatment quality by ensuring more constant contact between the disks and the soil. Modifications to the harrow to address these problems are planned for the 2002 season, and we expect to monitor the success of these changes.

Implementation

Brushcutting followed by a double pass with a harrow decreased treatment costs significantly compared with intensive mulching. This method also has the advantage of being based on tools that are easily available in some regions (agricultural tractors). Even though minor modifications to the harrow would likely improve the treat-

ment quality without significantly affecting the costs, the harrow would still probably fail to attain the treatment intensity produced by intensive mulching.

There are still a few options to explore for reducing the stand conversion costs for short-rotation plantations. However, as the present study demonstrated, the treatment cost and treatment intensity are directly related, and it thus remains necessary to define the optimal disturbance level required before we can identify an economically viable solution.

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