SILVOPASTURE WITH SHEEP AND HYBRID POPLAR

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ABSTRACT

More than 20,200 hectares (50,000 acres) of hybrid poplar have been managed in the Pacific Northwest primarily for the production of wood chips since 1983. Plantations have been established at densities of 1,450 to 2,200 trees per hectare (600 to 800 trees per acre) with rotations of six to eight years. More recently, management has focused on the production of more valuable solid wood products. This necessitates lower stocking rates of 750 trees per hectare (300 trees per acre) and longer rotations (10 to 12 years). At this wider spacing the development of a closed canopy is prolonged and substantial amounts of competing herbaceous vegetation must be controlled during a protracted period of stand establishment. Weed competition is detrimental to tree growth and provides habitat for tree-girdling field voles (Microtus spp.). GreenWood Resources conducted a trial of pasturing sheep in three age classes of young hybrid poplar plantations: age one, established with 1.8 m (six foot) whips; age two established with 2.1 m (seven foot) poles; and age four established with 36 cm (14 inch) cuttings. A cover crop of forage oats and forage rape was sown between the tree rows. Flocks were grazed on 0.4 hectare (one acre) plots during the month of August 2004. The cover crop and native herbaceous weeds were consumed and trampled by animal activity in all three plots. Sheep weight gain was average and sheep remained healthy and vigorous while grazing on the plots. Detrimental effects were not observed on two- and four-year-old trees, but trees suffered unacceptable levels of browsing in the one-year stand.

Keywords: Silvopasture, sheep, hybrid poplar, plantation management, weed control.

INTRODUCTION

The cultivation of hybrid poplar in the Pacific Northwest has advanced over the last 20 years from a research and developmental stage into a commercial enterprise occupying roughly 20,000 hectares (50,000 acres). Throughout this period, the strategy of poplar management has evolved as landowners have responded to changing commodity prices and advances in environmental amelioration technology. Conceived originally as an energy crop during the petroleum crisis of the 1970s, hybrid poplar was first commercialized by the pulp and paper industry in the mid-1980s. Stands have been commonly established at 1,450 to 2,200 trees per hectare (600 to 900 trees per acre) and managed on six- to eight-year rotations. Clean cultivation is normally practiced to ensure rapid stand establishment and high rates of survival. Both chemical and mechanical methods of weed control that are used can account for 40-60% of the total cost of
raising the crop exclusive of harvesting, processing, and transportation expense. At such moderately high planting densities, intensive weed control can be discontinued after the second year when the canopy closes and weeds are eliminated by shading.

With today’s near-record low chip prices, hybrid poplar plantations are being retooled to provide a variety of commodities including those destined for the solid wood market. Saw logs and peeler logs will be grown at stocking rates of 500 to 750 trees per hectare (200 to 300 trees per acre) for 12 to 15 years. Under this scheme of management with lower planting density, costly weed control measures are necessary through the fourth year.

The purpose of this study was to determine whether sheep grazing is compatible with tree farming, providing a cost-effective method of weed control at moderate to wide plantation densities.

**METHODS**

The study was established in three fields of the Columbia Tree Farm, near Clatskanie, Oregon, that encompassed the range of age classes within which sheep pasturing is possible given the amount of herbaceous cover and forage that can be sustained below an incomplete canopy. A newly planted field, a two-year-old field, and a four-year-old field were selected. The age four stand was established using 30 cm (12 inch) unrooted hardwood cuttings, the norm of poplar farming operations. To safeguard the two younger stands from sheep damage, larger planting stock was used. The age two stand was established using 1.8 m (six foot) unrooted whips and the newly planted, age one field was planted using 2.2 m (seven foot) unrooted poles. The age one field was planted in February 2004. The two-year-old stand had been planted in February 2003. The four-year-old stand was planted in April 2001. All three fields were established at 3.7 by 3.7 m (12 foot by 12 foot) spacing, or 750 trees per hectare (300 trees per acre).

In April, 0.4 hectare (one acre) unreplicated plots were located within each field in an area within which uniform soil conditions and excellent tree growth were observed. The plots were mowed then disked three times using a 2.4 m (eight foot) cover crop disk. A cover crop (mixture of forage oat and forage rape seed) was sown during the first week of May using a Howard spin-spreader with modified baffles to concentrate the seed in the disked tree rows. Sowing rates were 11 kg per hectare (10 lbs per acre) for the forage rape and 55 kg per hectare (50 lbs per acre) for the forage oats. Nitrogen fertilizer, in the form of ammonium sulphate, 21-0-0, was also added at the rate of 55 kg N per hectare (50 lbs N per acre) and applied simultaneously with the seed through the spreader. A final pass with a roller ensured the seed was firmly in contact with the soil (Figure 1). Moisture conditions were good at the time of sowing, and rain fell the day after sowing took place.

Cost of seed and fertilizer for each 0.4 hectare (one acre) plot was $67.50. It was not possible to accurately track equipment operating costs and time due to the location of the grazing plots within larger operational fields. Operating costs incurred on the test plots, associated with equipment moving, site preparation, and sowing were not representative of larger scale, more efficient farming operations.
By early June the oats had established well (Figure 2). The rape seed did not establish at all, presumably due to chemical burning by the nitrogen fertilizer which was spread at the same time as the seed. Electrified fencing was installed at the perimeter of each test plot. Each test plot was also fitted with a water supply system for the sheep (Figure 3).

Sheep were placed into the test plots the first week of August. The number of animals placed in each 0.4 hectare (one acre) plot was based on the available forage that would sustain the stock for one month. One month was selected as the duration of the grazing period so as to thoroughly evaluate the impact of the sheep on both the trees and the forage. Lambs aged four- to four-and one-half months were placed in the three plots at varying density (Table 1). The lambs varied in weight between 30 and 32 kg (60 and 65 lbs). The density was adjusted upwards or downwards in mid-August in an effort to more correctly balance the food supply (Table 1).

The reduction in the number of sheep in the four-year-old stand was necessary to allow the forage to sustain the animals through the month, while it was observed that both the age one and age two stands had adequate weed cover and forage to support additional sheep. The study was surveyed during the latter part of August to assess the health and condition of the sheep, the intensity of weed competition, and grazing damage to the tree stand. Pre- and post-treatment measurements of stem height and diameter were taken to evaluate the performance of the hybrid poplar inside each grazing plot and were paired with measurements from control plots established immediately adjacent to the grazing plots on the same microsite. Each plot consisted of 36 trees in a six tree-column by six tree-row array. Evaluation of the two- and four-year-old
stands consisted of growth increments in diameter at breast height (DBH), and stem height during the 2004 growing season. The one-year-old stand was evaluated solely in terms of height increment. Damage observations were also tallied at the time of height measurement in each age.

![Figure 2. Forage oat growth early July, in two-year-old field 02915.](image)
Figure 3. Electrified fencing and water supply, in four-year-old field 02705.

Table 1. Fields, field descriptions and stock density in silvopasture.

<table>
<thead>
<tr>
<th>Field</th>
<th>Stand description</th>
<th>Forage crop quality</th>
<th>Initial density, lambs per 0.4 hectare (1 acre) plot</th>
<th>Adjusted density, lambs per 0.4 hectare (1 acre) plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>06165</td>
<td>Age 1, from large whips</td>
<td>Below average</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>02915</td>
<td>Age 2, from whips</td>
<td>Good</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>02705</td>
<td>Age 4, from unrooted cuttings</td>
<td>Excellent</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

RESULTS

The forage oat cover crop did best in 02705 (four-year-old stand), while it performed the poorest in field 06165 (one-year-old) (Table 1). Native vegetation, consisting of horsetail (*Equisetum* spp.), grasses (*Poa* spp. and *Agropyron* spp.), elderberry (*Sambucus* spp.), and blackberry (*Rubus* spp.) also grew in the grazing plots, primarily along the tree row and the edges of the sown cover crop strip. It was readily apparent that the cover crop aided in suppressing native weed growth within the sown strip.

Considering the forage available the lambs did well. Individual lambs gained between 2.7 and 3.2 kg (6 and 7 lbs) on average during the month grazing in the hybrid poplar fields. This weight gain is considered average or slightly below average for lambs of this age grazing on forage. Had more forage rape been present in the plots higher weight gains might have been expected.
Without forage rape and only a limited amount of young native grasses, the mature oats may not have provided the protein quality and quantity that was needed for exceptional growth. Grazing these plots sooner with the oats in the boot stage may have given better weight results. However, the age of the lambs prevented us from grazing the test plots until August and high heat during late July and early August accelerated the maturation rate of the oats beyond the boot stage.

Four-year-old Stand, Field 02705

The forage oat cover crop performed best in this field and was associated with heavy horsetail growth that was confined close to the tree rows. This allowed for the heaviest initial stocking rate of 20 sheep, the highest of all three grazing plots. The number of animals was reduced after about ten days due to overgrazing of the oats. The trees showed only minor browsing of the lower leaves, up to a height of about one m (three feet) despite the overgrazing. Vegetation reduction, through grazing and animal trampling, including the horsetail, was readily observed. Forage crops and native vegetation alike were eaten and trodden to ground level. Initial measurement of height and diameter showed no significant differences between the grazed and control plot test trees. End of season height increment in the control plot was 3.3 m (11.0 feet), while height increment in the grazed plot was slightly, but not significantly larger, at 3.4 m (11.2 feet) (Table 2). Diameter increment was also slightly, but not significantly, larger for the grazed versus the control trees.

<table>
<thead>
<tr>
<th>Field</th>
<th>Stand Age (years)</th>
<th>Treatment</th>
<th>Diameter Increment</th>
<th>Height Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>02705</td>
<td>4</td>
<td>Grazed</td>
<td>3.1 cm (1.2 in)</td>
<td>3.4 m (11.2 feet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>2.7 cm (1.1 in)</td>
<td>3.3 m (11.0 feet)</td>
</tr>
<tr>
<td>02915</td>
<td>2</td>
<td>Grazed</td>
<td>2.0 cm (0.8 inches)</td>
<td>2.3 m (7.7 feet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>1.8 cm (0.7 inches)</td>
<td>2.2 m (7.5 feet)</td>
</tr>
<tr>
<td>06165</td>
<td>1</td>
<td>Grazed</td>
<td>N/A</td>
<td>0.2 m (0.6 feet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>N/A</td>
<td>0.2 m (0.6 feet)</td>
</tr>
</tbody>
</table>

Table 2. Diameter increment and height increment of hybrid poplar on grazed and control plots in three fields of the Columbia Tree Farm.

Two-year-old Stand, Field 02910

Forage oat cover crop performance in this plot was good. The sown forage oats were well grazed, along with volunteer grasses, blackberry, and elderberry. Sheep were also observed to have browsed leaves and softer branch tips of the trees to a height of about one m (three feet). A few trees, within about ten m (35 feet) of the water trough showed some minor but not significant chewing on the stem. No trees were pushed over or broken by the sheep, primarily due to the longer and stouter planting stock used to establish this field in 2003. As in field
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02705, height increment and diameter increment were slightly, but not significantly, larger for the grazed versus the control plot trees (Table 2).

One-year-old Stand, Field 06165

The forage oat cover crop was the thinnest in this field, leading to placement of fewer sheep, initially. Four more head were added in mid-August. The trees here were newly planted from whips. In their first season after planting, whips typically put the majority of their growth into developing root systems rather than the above ground portion of the tree. Consequently, height increments in both the grazed and control plots were 0.2 m (0.6 feet), much smaller than the established trees in the other two fields (Table 2). Again, no significant difference in height increment was found between the grazed and control plot trees. However, 17% of the trees inside the grazing plot suffered stem damage due to sheep chewing and pulling on succulent axillary and terminal shoots. This kind of damage typically results in loss of apical dominance, leading to forking or stem deformities as the tree matures, and is undesirable for both pulpwood and solid wood production. No trees in the control plot showed any damage.

CONCLUSIONS

Trees, which are older than one year, can successfully withstand sheep grazing without showing negative growth impacts. Trees that are one-year old, even if established from whips, cannot withstand the grazing pressure from sheep without suffering undesirable levels of damage.

With careful management of the stock density, sheep were well sustained on all three of the grazing plots. Weight gains in all animals were not exceptional, but were acceptable. All the animals remained healthy and showed good vigor during the grazing period.

Current grazing lease rates of $20.00 to $30.00 per hectare ($9.00 to $12.00 per acre) per month for sheep at the stocking levels used in this trial do not justify the materials and labor involved to establish a forage cover crop specifically for grazing. Furthermore, the cost of cover crop seed and the costs of mechanical seedbed preparation and sowing each greatly exceed grazing revenue.

As a result of this study, approximately 500 sheep were wintered in several recently harvested fields and two- and four-year-old fields of the Columbia Tree Farm, where they were sustained on native vegetation only. Two different sheep ranchers participated in this effort. Both ranchers have stated that the quality and quantity of native vegetation has been adequate to sustain their animals through February of 2005 and no negative impacts have been observed in the established plantations. Consequently, grazing of native vegetation could substitute for one or more mechanical or chemical weed control passes during the latter portions of the growing season, at a cost savings ranging from $54 to $108 per hectare ($21 to $43 per acre) for mechanical or $76 to $153 per hectare ($31 to $62 per acre) for chemical treatments without bearing the cost of a sown cover crop.
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