FOREST PRACTICES

Silviculture Practices Section

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SILVICULTURE NOTE 27

SITE PREPARATION FOR ESTABLISHING LODGEPOLE PINE ON BACKLOG SITES IN THE SUB-BOREAL SPRUCE ZONE

Introduction

Several major silvicultural trials were initiated in the 1980s in the northern interior of British Columbia to evaluate site preparation techniques and stock options for establishing coniferous plantations on backlog not satisfactorily restocked forest land. Results are reported here from two such trials (Doris Lake and Kluskus) involving lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) in the Sub-Boreal Spruce Zone.

Study Sites and Experimental Design

Both of the trials were established on backlog sites located in variants of the moist cold subzone of the Sub-Boreal Spruce Zone (SBSmc). Doris Lake is in the Morice Forest District northeast of Smithers at an elevation of 900 m. Most of the site is situated in crest and upper slope positions, predominantly moderately dry and nutrient poor, and classified as the submesic phase of the Sxw – huckleberry site series (SBSmc2/01c) (Banner *et al.* 1993). Soils are silt loam to clay loam, shallow to bedrock in places, and have moderate to high coarse fragment contents. Forest floors are Hemimors, 2–6 cm thick. Nine treatments were replicated in each of five experimental blocks, with 79–95 trees per plot. Site preparation treatments, begun in 1983, were completed in spring 1984, and planting took place in early June 1984.

Kluskus is located south of Vanderhoof in the Vanderhoof Forest District, on flat to gently rolling terrain at an elevation of 1036 m. Soils are silt loam with high coarse fragment contents at depth. Forest floors are Mormoders and Hemimors, varying in thickness from 2–17 cm. Most of the site resembles the Sxw – twinberry – coltsfoot site series (SBSmc3/05) (DeLong *et al.* 1993). However, compact basal till at depths of 20–40 cm restricts drainage and inhibits root penetration, and though soil moisture can be excessive in spring, moisture deficits occur during summer dry spells. At Kluskus, eight treatments were replicated in each of four experimental blocks, with 80 trees in total per plot, 48 of which were monitored. Site preparation treatments were carried out in the fall of 1986, and planting took place in May 1987.

Planting Stock

At Doris Lake, the stock type planted in untreated controls and in all site preparation treatments was standard-sized 2+0 bareroot lodgepole pine (Pl). Two alternate stock types, which were tested only in untreated controls, included large bareroot Pl (over-sized trees selected from standard bareroot stock), and PSB 211 1+0 Pl plug stock.

At Kluskus, PSB 211 1+0 pine stock was planted in untreated controls, the fertilizer treatment, and in all site preparation treatments. One alternate stock type, PSB 313 1+0 interior spruce (*Picea glauca* x *P. engelmannii* [Parry *ex* Engelm.]) (Sx), was tested only in untreated controls. Problems with a storage reefer may have compromised the quality of the Pl planting stock at Kluskus, and contributed to the unusually high mortality of pine on this site.

Treatments and Results

Planting without site preparation

At Doris Lake, both seedling survival and growth in untreated controls varied depending on stock type, with 211 plugs performing significantly better than either size of the bareroot stock (Table 1). Large bareroot seedlings had a slight advantage over the standard-sized bareroot stock.

Table 1. Survival and height of lodgepole pine (Pl) after 11 and 15 years at Doris Lake

Site prep. treatment by stock type	Survival (%)		Height (cm)	
	11 yrs	15 yrs	11 yrs	15 yrs
Pl/ PSB 211				
Untreated	77 a[a]	76 a	332 c	585 b
Pl/ large bareroot				
Untreated	54 e		310 d	
Pl/ standard bareroot				
Untreated	45 f	44 c	299 e	548 c
Bräcke patch	73 a		372 b	
Bräcke mound	58 e		371 b	
Mound + 6 cm	67 bc		377 b	
Mound + 14 cm	62 cd	62 b	389 a	646 a
Mound + 20 cm	59 de		372 b	
Blading	72 ab		371 b	

[a] Within columns, means followed by the same letter do not differ significantly by Duncan's Multiple Range Test ($p<0.05$).

Mechanical site preparation treatments (which were all planted with bareroot stock) improved early growth of the bareroot stock substantially, resulting in significantly better height and diameter at year 11 compared to untreated 211s. However, even though total height at 15 years was still significantly greater in the best-performing mechanical treatment (14 cm mounds) than in the untreated controls, annual height increments were the same as the controls (both stock types) by year 14 (Figure 1).

At Kluskus, the PSB 313 Sx planted without site preparation had a significantly higher survival rate than that of Pl (Table 2). However, tree height and volume at 10 years were substantially lower among the spruce, likely due in part to the sensitivity of that species to frost damage. During the first growing season, 35% of Sx seedlings were affected by frost.

Table 2. Survival and height of interior spruce (Sx) and lodgepole pine (Pl) after 10 growing seasons at Kluskus

Site prep. treatment by stock type	Survival (%)	Height (cm)
PSB 313/Sx		
Untreated	89 a[a]	101 d
PSB 211/Pl		
Untreated	66 bc	178 c
Fertilization	71 b	180 c
Disk trench berm	73 b	231 b
Disk trench furrow	79 ab	275 a
Sinkkilä patch	85 a	182 c
Mound	59 c	294 a
Blading	83 a	275 a

[a] Within columns, means followed by the same letter do not differ significantly by Duncan's Multiple Range Test ($p<0.05$).

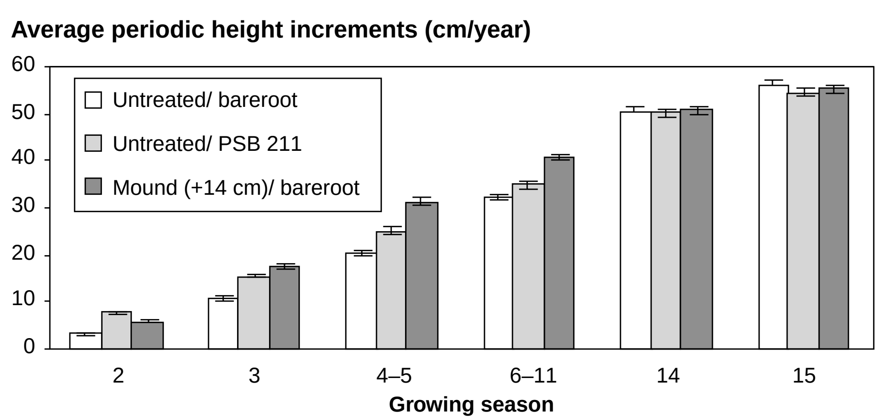

Figure 1. Average periodic height growth of lodgepole pine by growing season (with standard error bars) for selected treatments at Doris Lake.

Fertilization

At Kluskus, lodgepole pine were treated immediately after planting with 26 week Osmocote® 18-6-10 slow-release fertilizer (30 g was sprinkled around each seedling to a radius of 15 cm). There was virtually no response to this treatment, either in terms of survival or growth compared with the controls, nor did competing vegetation appear to have been stimulated.

Patch scarification

At Doris Lake, patch scarification was achieved using a Bräcke mounder, with the mounding shovels raised and inoperative. The patch treatment resulted in significantly better survival and growth at 11 years than with no treatment. Results were very similar to those for blading at this site.

At Kluskus, 1 m long patches were prepared with a Sinkkilä HMF scarifier mounted on a JD 740A skidder. This treatment resulted in better survival, but not growth, of Pl than the untreated control. Many seedlings in this treatment were over-topped by aspen, which partially accounts for poor performance, though exclusion of trees in aspen patches from the analysis did not significantly change the ranking of treatments. Although survival rates were relatively high during the unusually dry first growing season, over the long term the slightly depressed microsite likely placed seedlings at a disadvantage relative to those in other mechanical treatments by putting roots closer to the root-restricting basal till layer and exacerbating the soil conditions that were periodically too wet.

Disk trenching (Kluskus)

The equipment used for this treatment was a Donaren 180 disk trencher with a JD 740A skidder as the prime mover. Disk trenching was relatively ineffective on this site for a number of reasons, including the stony and compact character of the soils, and their frozen condition at the time of treatment. Also, the disk angle was not adjustable in this older-model equipment, and was not positioned optimally. The mode of operation of the equipment contributed as well, in that the speed of the prime mover was too high and insufficient down pressure was put on the disk to deal effectively with the difficult soil conditions.

Ideally, seedlings should have been planted in the hinge position on this site. However, very few of these microsites were created. As a result, most trees were planted in berm or trench positions, which were generally also poorly formed. Berms were small and irregular, and often separated from the trench by undisturbed forest floor. Trenches were mostly <10 cm deep, and exposed mineral soil accommodated only 58% of seedlings planted; 35% were planted into H horizon material and 7% into undisturbed microsites.

In spite of the poor quality of the planting spots produced, both the trench and berm treatments resulted in significantly greater height and volume growth than controls. Superior results from planting in the trench compared with the berm in this case can be attributed to the shallowness of the trenches that were formed and the fact that berms were poorly formed and accommodated only one-third of the trees, causing many to be planted in untreated ground. Subsequently, much of the area surrounding the Kluskus trial was operationally disk trenched with positive results.

Mounding

Mounding treatments at Doris Lake were carried out by an early model Bräcke mounder drawn by a D-7 fitted with a front-mounted V-blade. The thickness of the mineral soil cap on unaltered Bräcke mounds varied from <1 to 6 cm, and averaged approximately 2 cm. Mounds with thicker layers of capping material were manually constructed by supplementing Bräcke mounds with additional layers of mineral soil 6, 14, and 20 cm thick. Trees were planted centrally into mounds with 5 cm of the stem buried.

The mounding treatment at Kluskus was performed by the Ministry mounder, a prototype machine whose development has since been discontinued. Excavators are currently used to make mounds similar to those made by the Ministry mounder. Two-thirds of these mounds had mineral soil capping greater than 10 cm thick. As at Doris Lake, seedlings were planted deep, with only 5–10 cm of the shoot exposed.

At both sites, mounding treatments resulted in significantly greater tree height and diameter at 10 years than most other treatments, though survival rates during the first year were relatively low.

At Doris Lake, tree performance in mounds varied significantly depending on the thickness of the mineral soil capping on overturned forest floor material. After 11 growing seasons, the 14 cm mound proved significantly more effective than any other treatment, including mounds with lesser (6 cm) and greater (20 cm) capping depths, though these were not far behind. It would appear that, for mounding to be effective, mound volumes need to be large enough to deter regrowth of competing vegetation and heavy enough to consolidate the mat of disturbed forest floor at the base of the mound, so that hydrologic continuity with the underlying soil is established.

Though tree growth was substantially greater in mounds compared to untreated controls at Kluskus, sampling in one block showed no significant differences between the two treatments in foliar concentrations of most major nutrients, including N, P, and Ca (Macadam and Trowbridge 1998). Needle weights (g/100) were also virtually identical.

High rates of mortality in mounds during the first growing season at both sites were most likely due to moisture stress.

Blading

The blading treatment at Doris Lake was carried out by a D7-mounted V-blade. "Dipping-and-diving" due to slash and uneven ground left some patches untreated and some gouged. At Kluskus, A D7-mounted V-blade was used, and 3 m wide east–west strips were very lightly scarified. Trees were planted approximately 10 cm in from the edges of bladed strips.

Blading treatments performed well at both sites, on par with patch scarification at Doris Lake, and with disk trenching (such as it was) at Kluskus. Although blading can be a reasonably inexpensive treatment and, as was demonstrated here, produce satisfactory results in terms of survival and growth, achieving desirable microsites for planting while avoiding an undesirably high level of soil disturbance can be difficult. Potential concerns include soil compaction and structural damage associated with operating on sensitive soils or soils that are too moist, and excessive displacement of forest floor materials, which can damage soil fertility (particularly on dry, poor sites) and accelerate surface erosion. The relatively light blading treatment achieved at Kluskus required careful timing and considerable skill and caution on the part of the equipment operator.

Seedling mortality

Mortality was relatively high for most treatments at both sites, particularly during the first growing season. With mechanical site preparation, survival rates tended to stabilize after two growing seasons, but they continued to decline over time with no site preparation.

At Kluskus, low rates of survival were largely due to an unusually dry spring. The condition of the planting stock may also have contributed to high mortality among Pl. Drought took a particular toll on trees planted in raised microsites, especially in Ministry mounds, and to a lesser extent in disk trenched berms, while trees planted in slightly depressed microsites in mineral soil (Donaren trench, Sinkkilä patch, and blading) fared better in terms of survival during the first growing season.

At Doris Lake, mortality among PSB 211s was lower than it was for bareroot stock irrespective of site preparation treatment. As at Kluskus, mounding treatments resulted in higher rates of mortality during the first growing season than other mechanical treatments.

Conclusions

At Kluskus, a fertilizer treatment applied to the soil surface at the time of planting had no effect on the survival or growth of lodgepole pine.

While mounding treatments resulted in superior tree height and diameter during the early years of plantation establishment, the high cost of the treatment and relatively low rates of survival make it a poor choice on these sites with average and drier moisture regimes. Newly planted seedlings are particularly vulnerable to moisture stress until roots have become established, and since both Kluskus and Doris Lake are seasonally rather dry sites and mounding tends to aggravate existing soil moisture deficits, the high rates of mortality were not surprising.

Though seasonal moisture deficits occur at both sites, there are important ecological differences between them that affected response to treatments. While soils at Doris Lake are relatively porous and well drained, at Kluskus soil drainage and rooting are severely restricted by a dense layer of basal till close to the soil surface. Consequently, although treatments that created depressed microsites (Bräcke patch and V-blade) consistently improved survival and growth at Doris Lake, this was not the case at Kluskus.

The Sinkkilä patch treatment improved tree survival at Kluskus, but it failed to improve growth significantly relative to untreated controls. While the depressed microsite created by the patch scarifier mitigated drought conditions, and thereby decreased mortality during the first growing season, it also aggravated seasonal flooding, particularly during snowmelt. The placement of tree roots closer to dense root-restricting layers in the soil would also have contributed to slower growth relative to other mechanical treatments. The shallow, intermittent disk trenched furrows and very light blading treatments at Kluskus resulted in some degree of mineral soil exposure without creating significant depressions. Both treatments resulted in superior growth relative to either patch scarification or untreated controls.

At Doris Lake, site preparation significantly improved survival for bareroot stock. However, the survival of plug stock on untreated ground was greater than for any site preparation treatment planted with bareroot stock. By year 14, the annual height growth of bareroot and plug stock planted in the control was equal to the annual height growth on the 14 cm mound (the best treatment at year 10). If this trend persists, the difference in height growth between the bareroot stock planted on the untreated ground and the bareroot stock planted on the best site prepared ground will be approximately 1 m. The absolute gain in growth from site preparation on drier ecosystems such as Doris Lake, where the vegetation competition poses no serious threat, is generally less than on sites with a vegetation problem. On such sites, the manager needs to weigh the benefits of accelerated early growth against treatment costs.

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