FOREST PRACTICES

Harvesting and Silviculture Section

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SILVICULTURE NOTE 32

Disk trenching and broadcast burning effects on soil properties and lodgepole pine growth after two decades

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Summary

We disk trenched unburned and broadcast burned plots at a high-elevation clearcut. After 19 years, lodgepole pine survival was high regardless of burning or planting position in the disk trenching. Pine stem volume was significantly higher in hinge-planted than control positions after 19 years, with burning apparently enhancing the effects of the hinge position. Broadcast burning had no effect on either soil bulk density or chemical properties. In contrast, hinge soils had lower bulk density and greater soil nutrient availability than control soils for at least 10 years**.** These effects, presumably in combination with warmer and better drained soil conditions at the hinge, are assumed to have contributed to the pine growth responses. Neither burning nor disk trenching had negative effects on soil properties and foliar nutrition was also unaffected. Complete results are reported by Boateng et al. (2011).

Introduction

On boreal and sub-boreal sites in British Columbia, low soil and air temperature, excess soil moisture, and poor soil aeration are common limitations to seedling establishment (Örlander et al. 1990). Disk trenching is used to improve conditions for conifer seedling establishment and to improve planter access. Prescribed fire was also commonly used until about 1990, but its use subsequently declined due to concerns about air quality. In the mid-1980s, prescribed fire was sometimes used in combination with disk trenching, but no information was available to say whether this practice was beneficial to conifer performance. In 1988, the Tanli study was established on a high elevation SBSmc3 site to examine the individual and combined effects of broadcast burning and disk trenching planting position on lodgepole pine survival and growth. Soil physical and chemical characteristics were also assessed to provide information about long-term treatment effects on soil and to provide insight into the mechanisms of lodgepole pine growth responses.

Site descriptions and methods

The Tanli site is about 90 km south of Vanderhoof, B.C. in the SBSmc3 biogeoclimatic variant (site series 01with minor 07). It is at an elevation of 1240 m on a shallow (~2%) slope with southeast aspect. Soils are fine to coarse loam with 15-25% coarse fragment content and a rooting depth of 5-25 cm. The site was clearcut harvested and grapple-skidded in 1985/86.

A low-impact controlled burn was carried out on one half of the study area in fall 1986, and in fall 1987, both burned and unburned main plots.were trenched with a Wadell powered scarifier. In spring 1988, lodgepole pine container seedlings (PSB 211 1+0) were planted in each of the control (untreated), hinge, or trench positions in each of the burned and unburned main plots. The result was six burn-planting position treatments. Pine height and ground-level diameter (GLD) were measured in years 6, 10, and 19, and stem volume was calculated using the cone formula. In year 10, soil samples were collected to a depth of 10 cm and pine foliage was sampled. In year 20, soil and foliage were again sampled, but only 3 of the 6 treatments (unburned-hinge, unburned-control, and burned-control). Soil fine fraction (< 2 mm) bulk density was determined and soil chemical analysis was carried out to determine total C, total N, pH, conductivity, available P, mineralizable N, available ammonium-N, available nitrate-N, and exchangeable cations. Foliar samples were analysed for Al, B, Ca, Cu, Fe, Mg, Mn, P, K, S, and Zn. Analysis of variance was used to examine differences between burn-position combinations for each lodgepole pine assessment year, and for year 10 soil physical and chemical properties. Full analysis of year 20 soil and foliar data was not possible due to the partial sampling, but trends over time were qualitatively examined.

Results

Lodgepole pine survival and growth

After 19 years, pine survival was high (90-93%) in all burn-position treatments. Pine height, GLD, and volume were affected by a significant interaction between burning and planting position in all assessment years. In general, pine planted in the hinge position were larger than those in the control or trench bottom. Burning appeared to slightly enhance the positive effect of hinge planting (Figure 1).

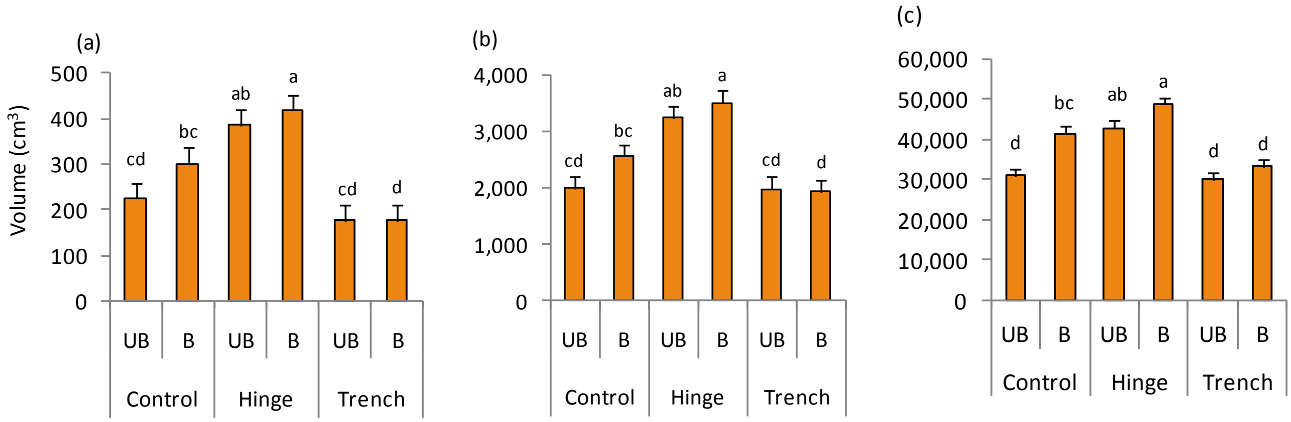

Figure 1. Lodgepole pine stem volume (a) 6 years, (b) 10 years, and (c) 19 years after planting. Error bars are one standard error. Within individual figures, means with the same letter do not differ significantly from each other (p≤0.05). UB is unburned and B is burned.

Soil properties and foliar nutrition

Broadcast burning had no effect on year 10 soil bulk density or chemical properties. In contrast, disk trenching reduced bulk density at the hinge position relative to the control for at least 10 years (Figure 2a). In year 10, total C and N and mineralizable N were all higher in the hinge position than in the control or trench bottom (Figure 2 b,c,d). Although soil pH was not significantly reduced in hinge soils, the increase in CEC is an indication of greater micronutrient availability in hinge relative to control soil Figure 2 e,f). In year 20, trends of lower bulk density, and higher C, N, and CEC were still apparent in hinge soils. Neither broadcast burning nor planting position had a significant effect on foliar Al, B, Ca, Cu, Fe, Mg, Mn, P, K, S, and Zn in year 10.

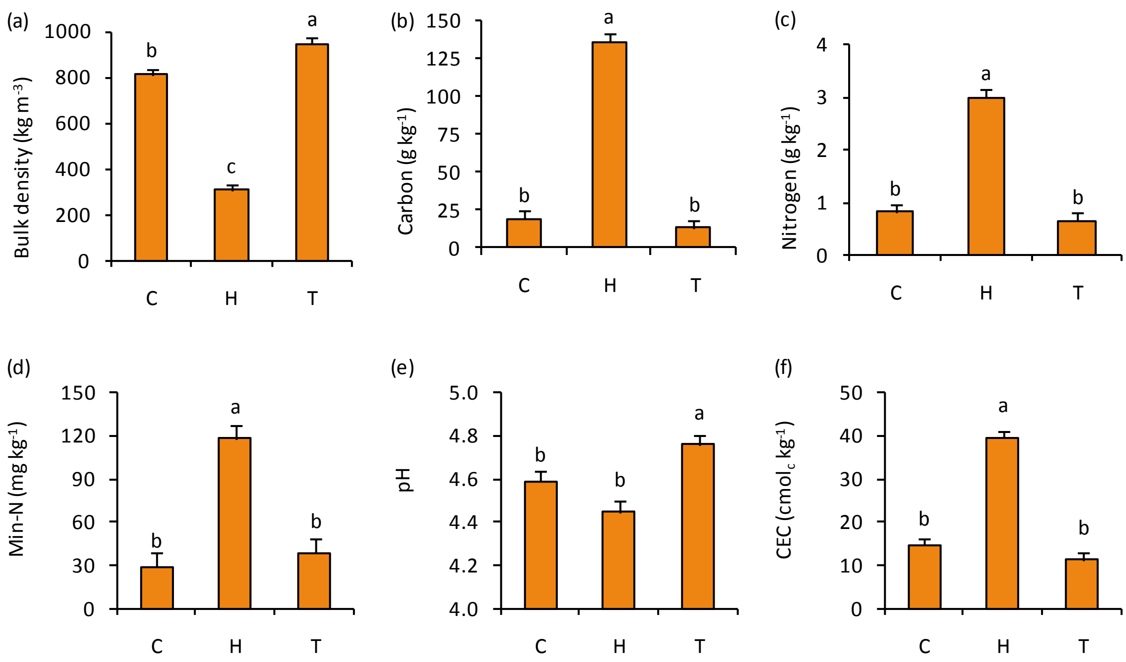

Figure 2. Year 10 soil characteristics by planting position across burned and unburned main plots: (a) fine fraction bulk density; (b) total carbon; (c) total nitrogen; (d) mineralizable nitrogen; (e) pH; (f) CEC. Error bars are one standard error. Within individual figures, means with the same letter do not differ significantly from each other ($p \leq 0.05$). C is control; H is hinge; T is trench.

Discussion

Site preparation was not necessary to achieve high survival of container-grown lodgepole pine seedlings on this high-elevation sub-boreal site. Planting at the hinge position gave pine an early growth advantage that persisted in the form of greater stem volume for at least 19 years. Broadcast burning appears to have interacted with planting position to enhance the growth advantage at the hinge (Figure 1). This may have been due to early effects of burning on seedling microclimate. Disk trenching, with or without burning, did not have negative effects on bulk density or soil nutrient availability. Negative impacts from the mechanical treatment had not been anticipated at the Tanli site because it was predominantly mesic and had only moderate sensitivity to disturbance (Curran et al. 1993). Other studies have also shown that low severity burns have little lasting effect on soil (Bulmer et al. 1998; Curran et al. 2006). In the 1980s, site preparation was used primarily to overcome problems related to seedling establishment, but this objective declined in importance as stock and management practices improved. Recent interest in site preparation focuses on its potential to benefit future timber supply (Hawkins et al. 2006). It could also accelerate early conifer growth, hence reducing the amount of time for harvested sites to move from carbon source to carbon sink. This topic requires detailed examination, however, because increases in juvenile conifer growth must be balanced against losses of soil carbon through the acceleration of biological processes and long term decreases in nutrient capital that are associated with site preparation. Increased understanding of the impacts of mechanical and burning treatments on soil properties and tree nutrition help us to weigh the economic and biological costs and benefits of applying MSP and burning treatments.

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