

Effects of Mechanical Site Preparation on Soil and Foliar Nutrients in the Drier Subzones of the IDF, MS, and ESSF Zones – Project 3.50

INTRODUCTION

Many of the mechanical site preparation techniques used in the dry subzones of the southern Interior involve the displacement of surface organic layers, which leaves a bare mineral soil surface into which the crop seedling is planted. Recent research has shown the advantages of these methods of site preparation in reducing both frost damage and vegetation competition, while at the same time increasing moisture availability. Few studies, however, have investigated how the removal of nutrient- and organic matter-rich materials from the forest floor might affect crop tree nutrition. This project addressed the question by evaluating the effects of forest floor removal, during mechanical site preparation, on soil and foliar nutrients.

METHODS

Three sites were selected in the Kamloops area to represent a transect from the lower elevation IDFdk subzone, through the MSxk subzone, to the highest elevation ESSFxc subzone. All sites had gravelly loam to clay loam soils and Mor humus forms. Soil moisture regimes were mesic and soil nutrient regimes were medium.

At each site, the results of mechanical scalping (surface organic matter removal using a front-mounted blade) were compared to those of a control. The mechanical treatments were completed in the fall of 1986 and all sites were planted the following spring. Douglas-fir (Fd) and lodgepole pine (Pl) were planted at the IDF site, lodgepole pine and interior spruce (Sx) at the MS site, and interior spruce at the ESSF site. Soils were sampled in July-August, 1987 and current-year seedling foliage was collected at the end of the third growing season in September 1989. Forest floor and mineral soil to 30 cm depth were sampled and analyzed for total carbon, total and mineralizable nitrogen, extractable phosphorus, sulphur, calcium, magnesium and potassium, and pH. Foliar samples were analyzed for both macro- and micronutrients.

SOIL NUTRIENTS

Soil macronutrients most affected by the scalping treatment were those that occurred in the highest proportion in the forest floor: nitrogen, sulphur, phosphorus and, to a lesser extent, potassium (Figure 1).

Total nitrogen in the scalped treatments ranged from 40 to 60% of that in the control. Furthermore, there was no

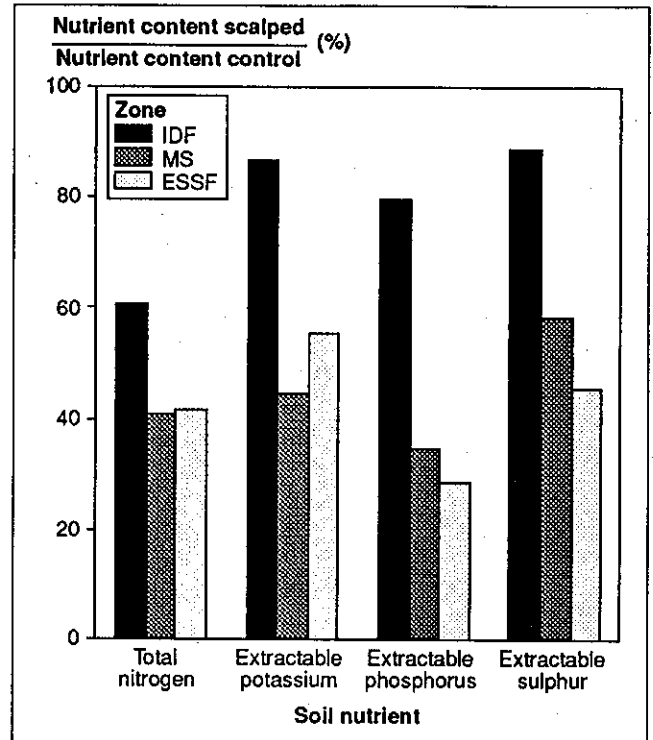


FIGURE 1. Soil nutrient content in the scalped treatment as percentage of the control treatment.

evidence of increased biological activity in the warmer scalped soils; carbon:nitrogen ratios did not decrease and mineralizable nitrogen content (an index of nitrogen availability) was much lower. Since nitrogen is generally regarded as the most common nutrient limitation to growth in Interior forests, these effects of the scalping treatment are notable. The impact was least at the IDF site because a greater proportion of total and mineralizable nitrogen was contained in the mineral soil. Also, seedling roots at the warmer, drier IDF site are more likely to obtain nutrients from deeper in the mineral soil than at the cooler, moister MS and ESSF sites.

Approximately 50% of extractable phosphorus was removed by the scalping treatment, although the mineral soil concentration of phosphorus remained high; and 20-30% of extractable sulphur was removed. Exchangeable cation (calcium, magnesium, potassium) content was high at all

three sites and the mechanical treatment appeared to have a small, biologically insignificant effect on these nutrients. Differences in pH between the two treatments were also small at all three sites.

FOLIAR NUTRIENTS

All species at each site, both in the control and in the scalped areas, were nitrogen deficient to some extent (Table 1). Most foliar concentrations decreased from the control to the scalped treatments; only for lodgepole pine at the IDF site was this decrease caused by a dilution of nutrient concentrations. At the IDF site, boron in lodgepole pine and Douglas-fir was the foliar element most altered by scalping (Tables 1 and 2). The decline in boron to a possible deficiency level appeared to be caused by forest floor removal. At the MS and ESSF sites, foliar nitrogen, sulphur, and boron were all reduced to probable deficiency levels by the scalping treatments. Foliar calcium, magnesium, phosphorus and manganese levels were also reduced at the the ESSF site, but concentrations of these nutrients appeared to be adequate to maintain seedling growth. At both the MS and ESSF sites, changes in foliar nutrients appeared to be directly related to removal of readily available nutrients in the forest floor.

TABLE 1. Nitrogen and boron concentrations in 3rd-year foliage at the three sites

Treatment	Foliar concentration				
	IDF		MS		ESSF
	Fd	PI	PI	Sx	Sx
Nitrogen (%)					
Control	1.22	1.37	1.49	1.34	1.33
Scalped	1.26	1.26	1.28	1.14	1.10
Boron (ppm)					
Control	12.4	12.9	13.9	10.0	7.7
Scalped	6.7	5.4	7.9	4.3	3.8

TABLE 2. Probable foliar nutrient deficiencies at each site

Site	Species	Deficient nutrients	
		Control	Scalped
IDF	Fd	Nitrogen, magnesium	Boron, nitrogen ^c
	PI	— ^a	Boron, sulphur ^d
MS	PI	— ^a	Boron ^a
	Sx	— ^{a, b}	Boron, sulphur, nitrogen
ESSF	Sx	Boron ^a	Boron, sulphur, nitrogen, magnesium

Possible additional deficiencies: a - nitrogen, sulphur; b - boron; c - magnesium; d - nitrogen, phosphorus.

GROWTH

At all three sites, survival, height, and stem diameter of all species were greater in the scalped treatments than in the control. This can be attributed to environmental factors that are more limiting to growth than is nutrition. These factors include soil moisture and vegetation competition, soil temperature, and frost damage. The positive effects of these microclimate changes have counteracted negative nutritional impacts over the 3-year period of the study.

MANAGEMENT IMPLICATIONS

Although the site preparation treatment used in the study was severe, we can draw several conclusions that have operational significance:

- On mesic and drier sites in these dry subzones, the forest floor is an important source of soil nitrogen, sulphur, and boron. Site preparation methods should therefore seek to retain the forest floor close to the growing seedling. This applies particularly to treatments that involve extensive forest floor removal, such as windrowing to reduce slash hazard or V-blading to remove grass competition. For less severe treatments such as disc trenching, some short-term deficiencies can be expected until the tree roots reach the displaced forest floor material.
- Nutrition of crop seedlings is impaired by site preparation that completely removes the forest floor. Although seedling nutrition does not appear to be the major growth-limiting factor in the short term, it will become more important as seedlings mature and factors such as frost and vegetation become less limiting.
- In the dry subzones of the southern Interior, removal of the forest floor appears to hamper seedling nutrition most in the ESSF zone, followed by the MS, and least in the IDF.

For more information on this project, contact:

Graeme Hope
 Ministry of Forests
 Kamloops Forest Region
 515 Columbia Street
 Kamloops, B.C.
 V2C 2T7
 (604) 828-4127