

Effects of Prescribed Fire on Soil Moisture and Temperature in Two Site Series of the SBS Zone Project 1.4

One of the primary goals of site preparation is to create better growing conditions for young seedlings. In the northern Sub-Boreal Spruce (SBS) Biogeoclimatic Zone, cold, wet soil conditions often hamper initial seedling growth. Broadcast burning is thought to influence both the soil temperature regime and soil moisture conditions within the rooting zone of seedlings. Until recently, however, there has been no research in the SBS to document how temperature and moisture conditions are affected by broadcast burning.

A pilot study of the effects of broadcast burning on soils and seedling growth in the SBSmc (SBSe) subzone was carried out at Joel Lake, 80 km NE of Smithers, in the Morice Forest District. The 25 ha clearcut, which included both mesic and subhygric site series, was logged in 1982 and broadcast burned in 1993. Joel Lake is the site of a comprehensive study of the impact of broadcast burning on fuels, vegetation, and site nutrients (EP953.03). Existing EP953 study plots, planted in 1984 with 2+0 bare-rooted interior spruce seedlings, provided an opportunity to investigate appropriate research methods for studying the relationships among broadcast burning, soil moisture and temperature regimes, and interior spruce seedling growth.

From May to October, 1985, soil temperature, soil moisture, and climatic parameters were recorded adjacent to four treatment plots. Each plot contained 49 spruce seedlings and represented a different combination of site series and site preparation:

1. untreated mesic;
2. burned mesic;
3. untreated subhygric; and
4. burned subhygric.

SEEDLING PERFORMANCE

Seedling performance to the end of the second growing season was not good. There was considerable mortality and many seedlings, particularly in untreated plots, suffered frost damage to leaders. However, there were substantial differences among the four treatments (Table 1). Survival and growth were best in the burned mesic plot and poorest in the untreated subhygric plot.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Planting ht. (cm)</th>
<th>2nd season ht. (cm)</th>
<th>survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated mesic</td>
<td>17.2 (±0.8)</td>
<td>12.9 (±0.9)</td>
<td>61</td>
</tr>
<tr>
<td>Burned mesic</td>
<td>15.8 (±0.6)</td>
<td>20.6 (±0.6)</td>
<td>82</td>
</tr>
<tr>
<td>Untreated subhygric</td>
<td>15.9 (±0.5)</td>
<td>10.1 (±0.5)</td>
<td>47</td>
</tr>
<tr>
<td>Burned subhygric</td>
<td>14.8 (±0.4)</td>
<td>16.7 (±1.1)</td>
<td>63</td>
</tr>
</tbody>
</table>

Note: values represent mean height (±standard error) or surviving seedlings

WEATHER CONDITIONS

The summer of 1985 was dry with only one heavy rainfall during July and August. Differences in recorded weather conditions between burned and untreated locations were few and slight. Temperatures below freezing were recorded periodically throughout the growing season, and were especially common at the ground surface on untreated mesic and subhygric plots.

SOIL TEMPERATURE

At depths of 0, 10, and 20 cm below the forest floor/mineral soil interface, soils in mesic treatment plots were substantially warmer than those in subhygric plots. This was attributed to deeper insulating forest floor layers on subhygric plots, (24 and 28 cm for unburned and burned plots, respectively) compared to those on mesic plots (9 and 11 cm). Figure 1 shows the relationship of forest floor depth to total degree days at a depth of 10 cm in the mineral soil.

Temperatures in burned and unburned mesic soils were mostly similar, except at the forest floor/mineral soil interface where the burned soil tended to be warmer. On subhygric sites the untreated soil was slightly warmer than the burned soil at all depths. This result was also attributed to differences in forest floor depth (4 cm greater in the burned soil).

A warming effect associated with darkening of the burned soil surface appears to have been transmitted to the forest floor/mineral soil interface in the mesic soil. This warming effect was not observed in the subhygric soils because of the strong insulating properties of the deeper forest floor layer.

\(^1\) Subzone designation in brackets refer to previous designation.
SOIL MOISTURE

In spite of dry weather conditions, soils in all treatments remained moist to wet throughout the growing season. At no time were soils dry enough to limit the rate of evapotranspiration. Seepage water, perched above a strongly compacted subsurface soil layer, apparently prevented soils from drying out. Under these wet conditions, no consistent differences in soil moisture could be detected between mastic and subhygic sites, nor between burned and unburned treatments.

RELATIONSHIPS AMONG STUDY VARIABLES

Formal analysis of the relationships among study variables is not possible in case studies such as this where treatment plots are not replicated. However, this project demonstrated a general trend toward decreasing soil degree-days with increasing depth of forest floor layers (Figure 1). No consistent relationships between soil temperature statistics and tree seedling performance could be established.

The results of the study suggest that:

1. Burning seems to improve initial seedling growth and survival. Factors in addition to soil climate (e.g. improved nutrient availability) are likely involved.

2. In mesic ecosystems of the SBSmc (SBSe), impacts of burning on rooting zone temperatures are probably due primarily to reductions in forest floor depth. Darkening of the soil surface appears to be less important, particularly where greater than 10 cm of residual forest floor remains.

3. On sites with deep forest floor layers (> 20 cm) it is unlikely that significant improvements in soil temperature will be achieved through burning unless forest floor layers are reduced in depth by 40 to 60 percent.

4. In poorly drained soils, reducing forest floor depth by burning is not likely to improve soil temperature, and may cause trees to suffer more frequently from water-logging. Mechanical treatments such as mounding, or planting on raised microsites, are advised.

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FIGURE 1. Degree-days for base temperatures of 0, 3, and 5°C at 10 cm depth in the mineral soil vs. total depth of forest floor layer.