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Survival and Growth of Western Larch Seedlings in Relation to Light Availability

Introduction

Western larch (*Larix occidentalis* Nutt.) is an important component of the montane forest in southeastern British Columbia. It grows in cool-temperate (IDF and ICH zones) and boreal climates (MS zone and, occasionally, ESSF zone). Larch is considered a very shade-intolerant species which can tolerate low light (partial shading) only during the seedling stage (the first 5 growing seasons). Typically, it regenerates after fire in the open on seedbeds exposed by burning. However, to what extent it tolerates low light and how various light environments affect its survival and growth is not known. The objective of our study was to determine the variation in survival and growth of western larch seedlings in relation to light availability and site conditions.

Materials and Methods

Five study sites were located on zonal sites in 4 biogeoclimatic subzones: sites 1, 2, and 3 were near Okanagan Falls, site 4 near Castlegar, and site 5 near Cranbrook (Table 1). The main differences between the sites were climate (temperature and precipitation) and soil moisture. Each study site included a portion of a clearcut and an adjacent forest stand. Canopies of these stands had different sizes of gaps providing for a variety of light environments in their understories. At each study site, approximately 500 one-year-old, container-grown seedlings were planted in mineral soil approximately 1.5 m apart in irregularly spaced transects extending from 60 m inside the clearcut, through the stand edge, to about 60 m inside the adjacent stand. Sites 1, 2, and 3 were planted in the spring of 1993 and sites 4 and 5 were planted in the spring of 1994.

Planted seedlings were monitored for three growing seasons. Light availability (percent of above-canopy light, PACL) for each seedling was determined during the second growing season by the procedure described in Chen *et al*. (1996). Each August, seedlings were examined for survival and injuries. The seedlings with a history of damage were excluded from sampling and data analysis. During the third growing season before leaf fall, 60 to 100 surviving seedlings on each study site were selected for random destructive sampling. The total height (H) and base diameter (D) of the sampled seedlings were measured in the field. After excavation, the seedlings were stored in a portable cooler, and transported to a laboratory to determine total biomass.

Table 1. Study site characteristics.

	Elevation (m)	Subzone[1]	SMR[2]
Site 1	850	IDFxh	VD
Site 2	1250	IDFdm	MD
Site 3	1525	MSdm	SD
Site 4	825	ICHmw	F
Site 5	1100	IDFdm	MD

[1] Biogeoclimatic subzones: IDFxh - Very Dry Hot Interior Douglas-fir; IDFdm - Dry Mild Interior Douglas-fir; MSdm - Dry Mild Montane Spruce; and ICHmw - Moist Warm Interior Cedar-Hemlock.

[2] SMR (actual soil moisture regime): VD - very dry; MD - moderately dry; SD - slightly dry, F - fresh

Results

How survival varied with light availability

Survival of planted seedlings varied with light availability and study site (Figure 1). Survival significantly (p <0.05) decreased with decreasing light from intermediate to low light levels, but there were no significant differences with increasing light from intermediate to high light levels. However, this pattern varied greatly among the study sites. At the end of the 1st growing season, survival ranged from 10 to 100% and did not vary significantly among 10 light classes except for a very low survival in the 0.1 - 10.0% light class on site 4. At the end of the 2nd growing season, accumulated survival significantly decreased in most of the light classes across all the study sites. The accumulated survival at the end of the 3rd growing season continued to decrease: it ranged from 0 to 60% at light availability <30% and from 30 to 100% at light availability >30% across the study sites. Therefore, we conclude that during the seedling stage western larch may survive low light levels as low as 10%.

In relation to site quality, the accumulated survival at the end of the 3rd growing season at high light levels increased with in-

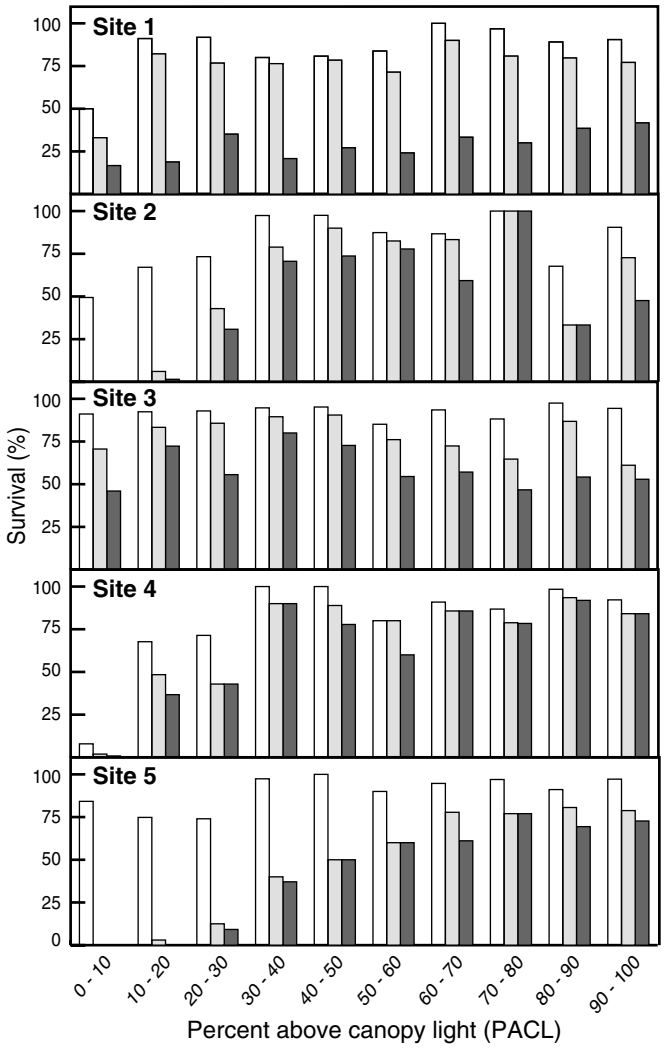

Figure 1. Survival of study seedlings in relation to light availability at the end of the first ( ), second ( ) and third ( ) growing season.

creasing precipitation, decreasing temperature, and increasing soil moisture. At low light levels, a similar pattern occurred, although the trend was less pronounced.

How growth performance varied with light availability

Growth characters measured on surviving seedlings at the end of third growing season indicated that base diameter and total biomass drastically increased with increasing light availability but the increase in height growth was less pronounced (Figure 2). While the increases in diameter and total biomass were consistent with increasing light, there was no significant increase in height growth with increasing light from 40 to 100%. At the end of the 3rd growing season, the mean height, the mean base diameter, and the mean total biomass of planted seedlings in full light was 1.7-, 2.3-, and 7- fold greater than those of seedlings grown in low light.

The response of growth to light availability was not signifcantly affected by climate (subzone) or soil moisture regime. Therefore, we conclude that regardless of site, high light levels can maximize the growth potential of western larch seedlings.

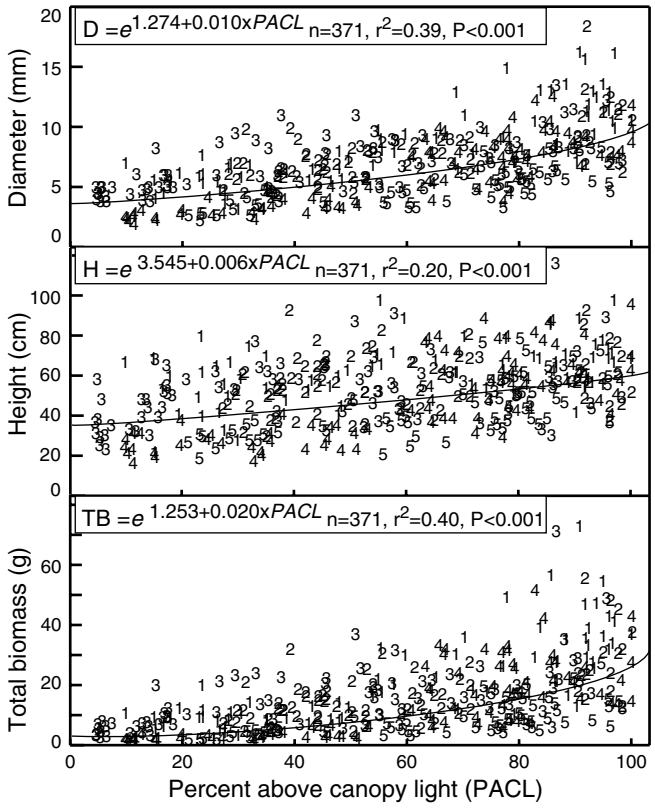

Figure 2. Growth of study seedlings in relation to light availability at the end of the third growing season.

Implications for management

Considering the constant decline in survival (faster in low than high light) in the first 3 growing seasons, we expect that survival (1) will further decline across all the study sites in low light environments (<30%) but (2) will stay more or less constant between 40 and 100% of light availability. In low light levels the growth potential of the surviving seedlings will not be realized, resulting in low vigour and increased competition with vegetation present on the site. This will postpone the time to reach the free-to-grow stage. We conclude that regeneration cutting methods other than clearcutting, seedtree or patch-cutting should not be considered if the objective is to regenerate western larch as a major timber crop species.

Reference

Chen, H.Y.H., Klinka, K., and Kayahara, G.J. 1996. Effects of light on growth, crown architecture, and specific leaf area for naturally established *Pinus contorta* and *Pseudotsuga menziesii* var. *glauca.* saplings. Can. J. For. Res. 26: 1149-1157.

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