Forest Sciences

Prince Rupert Forest Region

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Growth of planted lodgepole pine and hybrid spruce following chemical and manual vegetation control on a frost-prone site

Research Issue Groups:

Forest Biology

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It has been clearly demonstrated that shrubs and herbs can be a serious impediment to the successful establishment and early growth of planted conifer seedlings. Interference by associated vegetation can be negative, either by competition for resources (light, water, or nutrients) or by modification of the physical environment. In some cases, however, associated vegetation can have a positive impact on conifer seedlings. Nitrogen fixing plants are a well documented example of such a beneficial relationship. Another, less well understood example, is the protection that associated vegetation can provide for newly planted conifer seedlings that are susceptible to growing season frost injury. Vegetation can reduce frost damage depending on its height, structure, and density. Overtopping shrubs have reduced the incidence of frost damage in some conifer plantations.

This study, located on a frost prone site, examines the growth response of lodgepole pine and hybrid spruce to chemical and manual vegetation control methods applied throughout the growing season. Extensive frost damage to young spruce plantations has been observed at locations throughout British Columbia. The ability of conifer seedlings to become established and their subsequent growth will depend on the interactions between biotic and abiotic factors and the varying stresses they may impose on the seedlings.

In the trial, established in 1986, experimental plots were treated with either 1.4 or 2.1kg a.i./ha of glyphosate or a manual cutting at 4 different times throughout the growing season. In the spring of 1987, the experiment was planted with 1-year-old, container-grown lodgepole pine and hybrid spruce seedlings. The trees were measured at the end of the fifth growing season for total height (nearest 1 cm) and basal diameter (1 cm above ground level). Frost damage was assessed at the end of each growing season.

The climatic data gathered during 1987 indicated a typical growing season for the ICH subzone. Between May 5 and September 17, total rainfall measured 140 mm. An An extended dry period was recorded from August 5 to September 2. During the measurement period, mean daily temperature at 1.5 m above the ground ranged from 2.5 to 20.5° C and averaged 12.3° C (Fig. 1). Minimum temperatures ranged from -5 to 15° C with an average of 4.8° C (Fig. 1). During the active growing season, there were a total of 27 days where the temperature fell below freezing. Air temperatures at the surface can be 2 to 5° C colder than those recorded at 1.5 to 2 meters above the ground. This suggests the possibility of between 40 (using a minimum of 2° at 1.5m) and 76 (minimum of 5°) days during the growing season with surface temperatures at or below freezing.

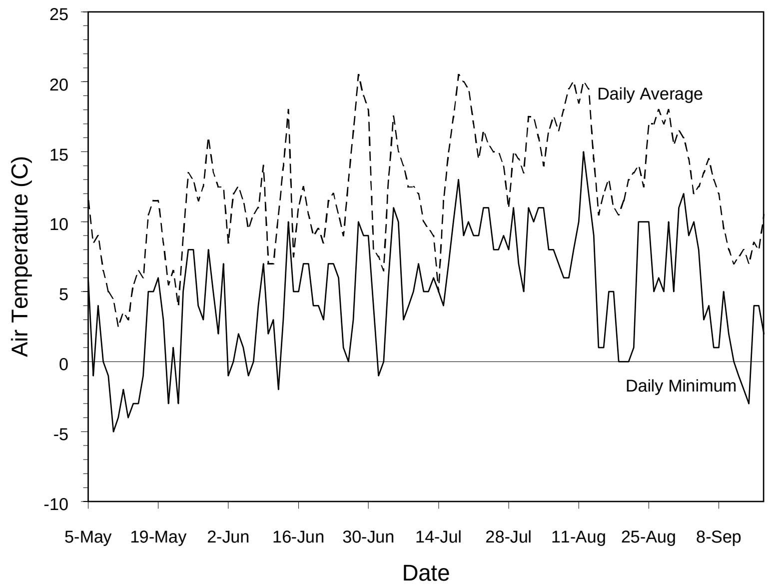

Figure 1. Daily air temperature (°C) at 1.5 m during the 1987 growing season.

Lodgepole pine

At the end of the fifth growing season, overall survival of the planted lodgepole pine for all treatment and timing combinations totaled 95 percent. The method of vegetation control was the most important factor influencing lodgepole pine height and diameter growth. The timing of the treatments was of lesser importance. After 5 years, both total height and diameter were similar in the untreated control and manual cutting treatments (Table 1). The manual treatment did result in slightly taller and larger diameter trees than the untreated control, but the difference was not significant. Both chemical treatments produced taller and larger diameter trees than either the control or manual cutting treatments. No differences in growth were found between the low (1.4 kg a.i./ha) and high (2.1 kg a.i./ha) rates of glyphosate application (Table 1). No frost damage was observed on any of the lodgepole pine during the five years of assessment.

Hybrid spruce

At the end of the fifth growing season, overall survival of the planted hybrid spruce for all treatment and timing combinations totaled 99 percent. The diameter growth of

Table 1. Means for effects of vegetation control treatment on height and diameter of lodgepole pine and diameter of hybrid spruce at 5 years post-treatment.

	Lodgepole Pine		**Hybrid Spruce**
Treatment	Height (cm)	Diameter (mm)	Diameter (mm)
Control	108	16.8	9.3
Manual	118.5	19.3	10.2
1.4 kg a.i./ha	152.4	26.8	13.6
2.1 kg a.i./ha	153.9	27.9	13.5

Table 2. Number and percent of hybrid spruce seedlings damaged by frost at the end of first growing season (1987), by vegetation cover class.

Veg. Cover Class (%)	Total Number of trees	Number frost damaged	% frost damaged	% of total frost damaged
0 to 15	318	108	34	71
15 to 30	120	24	20	16
30+	202	20	10	13
Total	640	152	24	100

hybrid spruce was strongly influenced by the method of vegetation control but not by the timing of the treatments. Both the high and low rates of glyphosate application resulted in significantly larger diameter trees than either the control or manual cutting treatments. The low rate of chemical produced, on average, the largest diameter spruce trees after 5 years (Table 1), however, the difference between the low and high rate was not significant. Diameter of trees in the manually cut and untreated control plots were similar after 5 growing seasons (Table 1).

The planted hybrid spruce suffered repeated summer frost damage over the five years of the study. The level of frost damage was found to be directly related to the amount of thimbleberry cover. Assessments made at the end of the first growing season (1987) showed that 24% of the spruce seedlings were damaged by summer frosts. Over 70% of these damaged seedlings were located in plots where the competing thimbleberry cover had been reduced to less than 15% (Table 2). By the end of the 5th growing season, 83% of the planted spruce had been damaged by at least one, and usually several, frost events. The height growth of the spruce was significantly impacted by this frost damage. After five growing seasons, hybrid spruce total height is least between 8 and 17% thimbleberry cover. Height increased at cover levels below 8% or above 17%. Height increased rapidly as thimbleberry cover decreased below 8%. As cover increased from 17 to 35%, height gradually increased. Total height is the same at 3 and 35% thimbleberry cover (Fig. 2).

Discussion

The effect of site preparation vegetation control on the growth of hybrid spruce and lodgepole pine is apparent 5 years after planting. The method of vegetation control and the degree of conifer frost tolerance were the critical factors affecting seedling growth performance. The use of glyphosate to control competing vegetation dramatically improved conifer growth, however, the high rate proved to be no better than the low rate. Manual vegetation control did not improve conifer growth. After 5 growing seasons, the results of this trial indicate that hybrid spruce diameter growth and lodgepole pine height and diameter growth increase as thimbleberry cover is reduced. The tree seedlings exhibit a classic growth response to competition for resources. Growth slowly increases as thimbleberry is reduced from 35 to 5% cover and then increases rapidly below 5% cover. A treatment response threshold of 5% is indicated, suggesting thimbleberry cover must be below this level for substantial gains in growth to occur. The relationship between the height growth of hybrid spruce and thimbleberry cover, however, does not follow this pattern. In this case, minimum seedling height growth occurred at intermediate thimbleberry cover, indicating beneficial effects at both very low covers and at intermediate covers, even though a negative competitive effect would be expected. Vegetative cover, though competing for growing space and site resources, can provide conifer seedlings some degree of frost protection. On the frost-prone site in our study, the reduction of thimbleberry cover from 35 to 17% increased frost damage and reduced hybrid spruce height growth. Height growth did not improve until

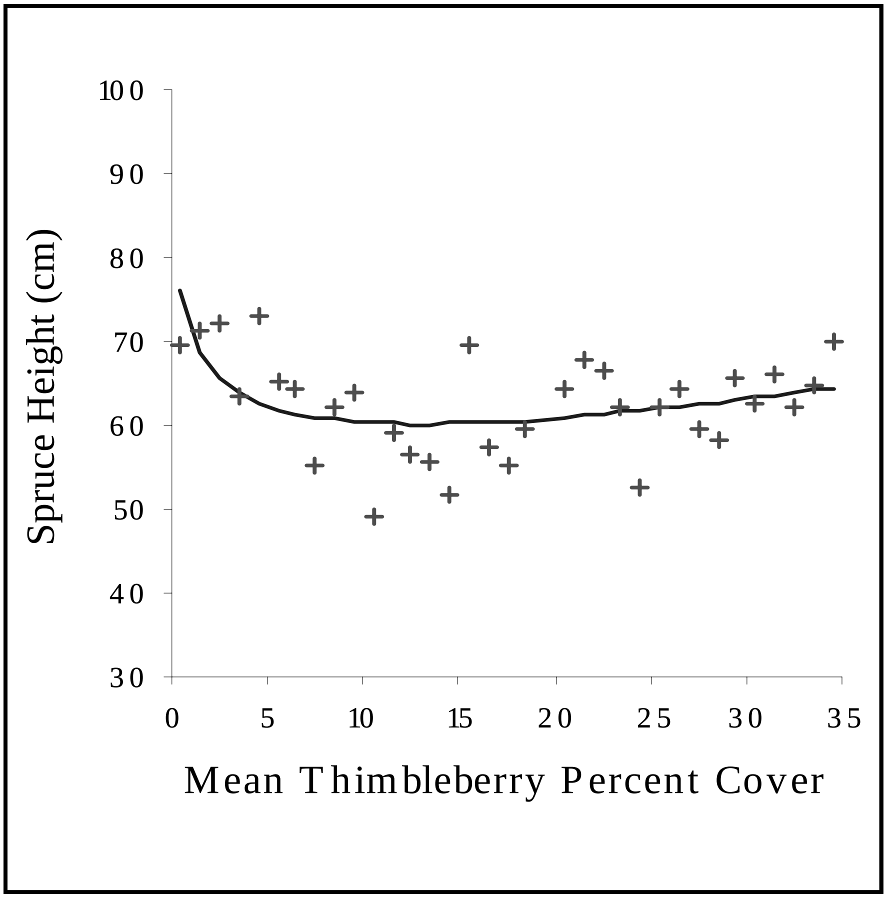

Figure 2. Combined power and exponential regression model of 5th year hybrid spruce height (cm) vs mean thimbleberry cover (%).

thimbleberry cover decreased below 8 percent (Fig. 2).

Summary

It is the microsite conditions faced by individual conifer seedlings that ultimately determine growth performance. In young plantations, microsite conditions result from the interaction of climate and interfering vegetation. In areas where minimum temperatures commonly fall below freezing during the growing season, air temperature can play a major role in the reforestation success. There is little the silviculturist can do to modify the climate, but any limitations the climate places on seedling performance must be understood. In areas subject to frequent summer frosts, reductions in cover of associated vegetation may be more detrimental than beneficial when dealing with frost-susceptible species such as hybrid spruce. Species that are more frost-tolerant, like lodgepole pine, respond to vegetation control in a more predictable manner with height and diameter growth continuing to improve as competition is reduced.

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References and Suggested Reading

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