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White spruce is a specialist for low temperatures

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It is well known that in northern, temperature limited, environments plant growth responds very positively to increases in temperature as long as other resources (e.g. water) are not limiting. However, some species might respond stronger to temperature increases than others. Based upon laboratory and field experiments, we have determined several features related to the physiology and growth of white spruce in response to low temperatures:



In the field, white spruce was able to begin photosynthesis in spring time when soil temperatures were still near 0°C (much earlier than pine and well before leaf flush of aspen). Similarly, white spruce continued to photosynthesize until late October, well after aspen leaf fall and during days when night time temperature were as low as -12° C.

There was little difference in photosynthesis at air temperature of 15° to 25° C, but photosynthesis was greatly suppressed at 35° C.

In a growthchamber experiment, white spruce seedlings were grown for one season at soil temperatures of 5, 15° and 25° C with a constant air temperature of 20° C.



White spruce was able to grow roots at 5° C, but as can be expected root growth increased with increasing soil temperature.

However, after the first growing season there were no differences in seedling height, total mass, transpiration or photosynthetic rates between the three soil temperatures. At the end of the season, root carbohydrates reserves were greatest in the 5° C.

Implications:

- Tolerance to cold conditions allows understory white spruce to take advantage of the leaf-off period of aspen in spring and fall. This provides a survival and carbon gain advantage.
- The ability of white spruce to grow roots and take up water under cold soil conditions provides white spruce with an adaptation for growth on colder sites.
- Site preparation to warm the soil conditions may not be as important to growth in white spruce as in other species.
- Under climate change, warmer soil and air temperatures may make white spruce poorly adapted for survival and growth in the southern range of its distribution.

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Further Information:

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