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How does wind and stem bending affect height and diameter growth of pine?

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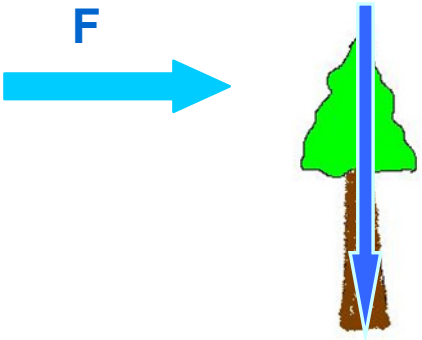
Most forest scientists believe that the allocation of resources to height or diameter growth in trees is controlled by competition for light. However, an alternative explanation relates to how trees allocate resources in response to wind. The uniform stress hypothesis suggests that trees grow in diameter to counteract the increasing bending moment (tendency to bend at the base) from wind energy as trees grow taller. Eventually because of the increased mechanical constraints from wind, height growth of very tall trees approaches 0 and nearly all resources are put into diameter growth.

In this study, we tested the effect of bending stress on the relative height and diameter growth by guying trees to prevent them from bending significantly in wind. Guying was done at 10m height just below the live crown, on groups of 10-15 trees, in three 50 years old, 15m-tall lodgepole pine stands in western Alberta. After 6 years, the trees were cut down, and the height and diameter growth of dominant trees were determined before and after the guying treatment.



Bending moment=F* leverage

Findings: Height increment of guyed trees increased by 40% after the 6 years of guying, compared to a 20% decline for the controls.

In guyed trees, there was an increase in the proportion of latewood at the height of guying.

There was a decrease in diameter growth at 1.3m height and an increase in diameter growth at the height of guying, relative to the control trees. This corresponded to the change in bending stress at each height.

Trees guyed together to prevent sway in wind.

Implications: Since bending stress has a large impact on the allocation of resources to height and diameter of pine trees. The use of height to diameter ratios to assess competitive effects might be questionable as height to diameter ratio could be attributed to wind exposure and not competition.

In maturing pine stands, height growth is limited by the gradual increase in bending stress as trees grow taller and are exposed to more wind. Stands in zones with high winds are likely to have reduced height growth and site index, solely because they experience more bending stress.

Density management that modifies wind penetration into stands will affect tree form and wood quality.

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Further Information:

Meng, S.X., Lieffers, V.J., Reid, D.E.B., Rudnicki, M. Silins, U. and Jin, M. 2006. Reduced stem bending increases the height growth of tall pines. J. Exp. Bot. 57:3175-3182.

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