NORTH CENTRAL FOREST EXPERIMENT STATION

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SOIL PROPERTIES RELATED TO CONIFEROUS SEEDLING HEIGHT GROWTH IN NORTHERN WISCONSIN[1]

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ABSTRACT.—Soil properties (organic matter content, pH, texture, and microclimate) were related to early height growth of jack pine (*Pinus banksiana,* Lamb.), red pine (*Pinus resinosa,* Ait.), white spruce (*Picea glauca,* (Moench) Voss), and hybrid larch (*Larix leptolepis* x *Larix decidua*) planted in northern Wisconsin. Based on 2-year height growth, jack pine and hybrid larch performed best on these silty soils.

KEY WORDS: Organic matter, soil pH, jack pine, red pine, white spruce, hybrid larch.

Seedling early growth and survival are important aspects of forest management to ensure a quick economic return to the landowner. The optimization of tree growth by matching tree species to the most suitable soil is one management technique that shows promise in achieving that goal. Yet in order to do this, a clear understanding of the most influential soil factors is essential.

The importance and need for soil evaluation in relation to timber production has been emphasized in many reports. Stevens and Wertz (1971) estimated that the Nicolet area of Wisconsin has the potential for a 60 percent increase in sawtimber production by matching species to the soils. Therefore, we tested jack pine, red pine, white spruce, and hybrid larch in this area of northern Wisconsin to determine which soil properties were best related to early height growth of seedlings.

METHODS

The experimental site is on the Nicolet National Forest in northern Wisconsin. The soil is Padus silt loam, an Alfic Haplorthod, of the coarse-loamy, mixed, frigid family, and consists of well-drained loamy sediments over sands and gravels on outwash plains, terraces, and pitted outwash.

The 1.0-ha site was cleared and disked in 1974 and hand planted with containerized seedlings in August, 1974. The site was divided into four blocks so each species occupied its own 0.25-ha block. Each species block (0.25 ha) contains 4 replications in a

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randomized complete block design with 16 plots in each replication and 16 seedlings planted in each plot at a 2 meter spacing. In the fall of 1976, soil samples were extracted from the surface 15 centimeters (6 inches) of 60 randomly selected plots—17 from jack pine, 13 from red pine, 16 from hybrid larch, and 14 from white spruce. The average plot height growth was determined from those surviving from the original 16 seedlings planted in the plot.

Soil organic matter content was determined by the Walkley-Black method (Black 1965), soil texture by hydrometer, soil pH by potentiometer, and soil buffering with SMP buffer and potentiometer (Shoemaker *et al.*1961). Soil data were then regressed with normalized height growth data.

It was hypothesized that microrelief variations could have affected seedling performance. To test for this, the site was stratified into high and low microsites for all species except larch, and an analysis of variance test was run on soil and growth data.

RESULTS AND DISCUSSION

Higher soil organic matter was related to increased growth of jack pine, but not the other three species (fig. 1). This may suggest a greater growth potential for jack pine on soils with more organic matter. If a site is to be prepared for jack pine, methods that incorporate surface organic layers may be more desirable. The other three species grew well over the range of organic matter contents and may be advantageous for planting on soils whose surface organic layers have been depleted or completely removed.

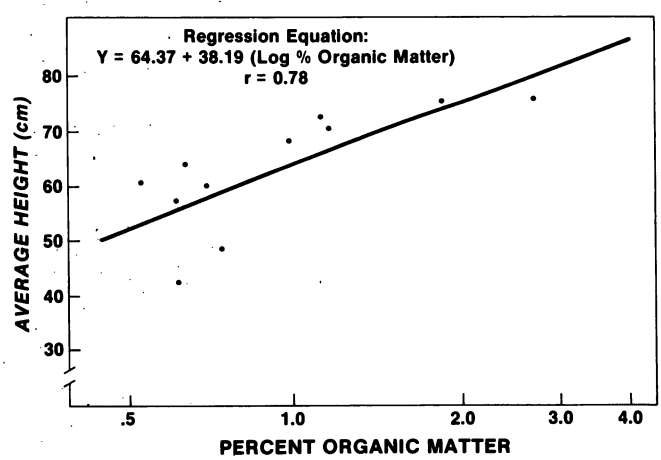

Figure 1.—*Relation of amount of soil organic matter to jack pine height growth.*

Soil pH was significantly negatively correlated to red pine and white spruce growth (fig. 2). Both species grew better in the strongly acid (pH = 5.1 – 5.5) range. Jack pine and hybrid larch grew well over the range of pH's from 5.0 to 6.0.

White spruce and jack pine grew better on the coarser soil textures (fig. 3). Hybrid larch, however, grew better on the finer textures of the site (fig. 4). Other soil textural effects, such as surface runoff, soil compaction, infiltration, frost heaving, and aeration may have also had some effect on seedling growth.

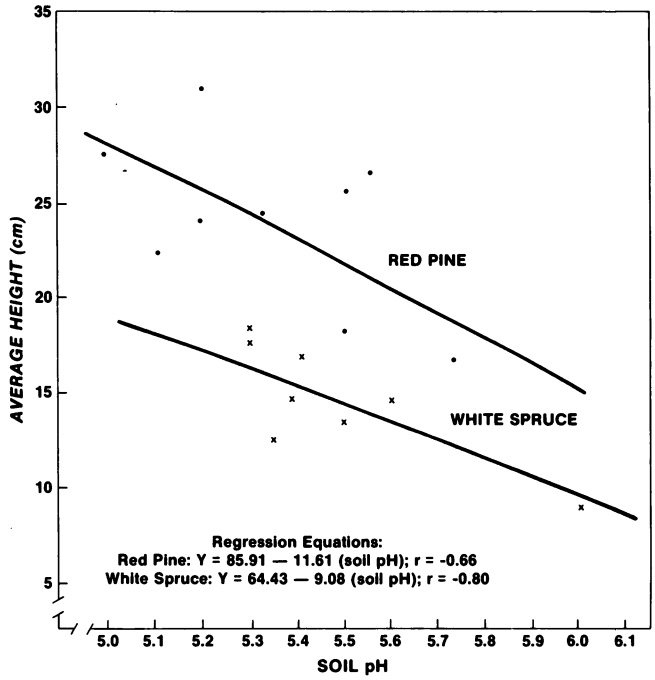

Figure 2.—*Relation of soil pH to red pine and white spruce height growth.*

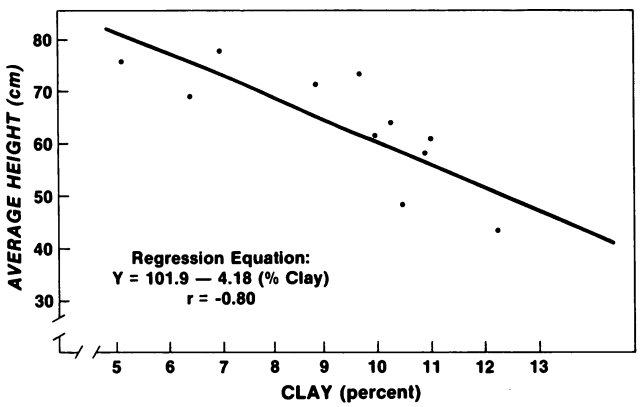

Figure 3.—*Relation of amount of clay in soil to jack pine height growth.*

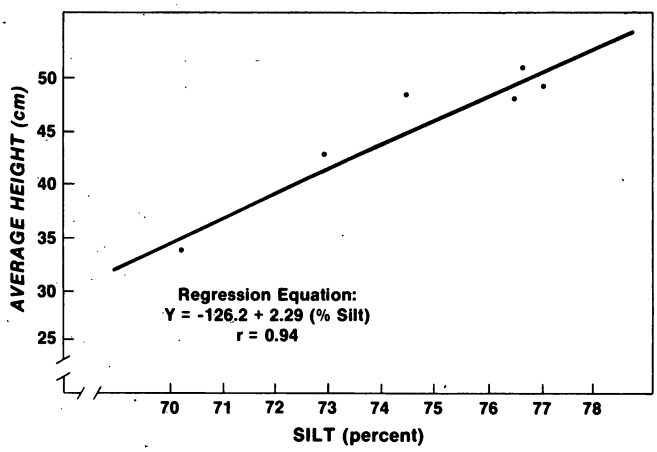

Figure 4.—*Relation of amount of silt in soil to larch height growth.*

Height growth was significantly different between high and low microsites for jack and red pine. This might imply that microclimate differences, such as humidity, radiation, or temperature may have affected seedling growth. However, because soil properties were also significantly different, no specific conclusion could be drawn.

Jack pine and hybrid larch have better early growth and survival on these soils than red pine and white spruce. From the soil and growth relations, hybrid larch growth was not related to organic matter and had better growth in the loamier textures of the site. Jack pine was related positively to organic matter and negatively to percent clay, but nevertheless, good growth and survival were apparent.

Recent research has shown that red pine eventually outproduces jack pine on similar soils throughout the Lake States due to its greater basal area (Alban 1978). However, another recent study has shown great potential for intensively cultured jack pine (Zavitkovski and Dawson 1978). In this study, jack pine biomass production was two to several times higher in intensively cultured silvicultural systems than in jack pine plantations grown under traditional silvicultural systems.

Site preparation methods appeared to cause considerable soil variation between plots. An evaluation of soil variation and stratification prior to planting may be advantageous in future tree planting experiments. By doing this, the experimental design could be adapted to anticipated growth differences.

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