Air Humidity, Ground Water Extend Growing Season in Wisconsin

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The length o f the growing season is usually associated with the temperature. Actually the active growth period o f forest stands is determined as much by the available water supply as by temperature. This article describes a more than 100 percent extension o f the growing sea son o f forest plantations in Lake Superior's fog belt under the influences o f "intersylvan rain" and naturally subirrigated soils.

Foresters often associate the length of the growing season with temperature range and the period of time between the last and first killing frosts. This emphasis on the temperature factor has been expressed particularly in the classification of H. Mayr (1909), who subdivided the world's forests into units delineated by ranges of temperature in the growing season such as "castanetum," "fagetum," and "picetum." But the period of active growth of forest stands is actually determined as much by the supply of available water provided by precipitation, condensation of vapor, or natural subirrigation as by temperature. This is especially true with coarse sandy soils of field moisture capacities below 8 percent by volume and clay soils of high hygroscopic and inner-capillary retention. The relationship is illustrated by the following example.

A very large area of central Wisconsin is formed by fluvio-glacial and lacustrine deposits of coarse, largely quartzitic sands. The predominant fertility level of these soils is indicated by the following analysis: 9 percent of silt and clay particles, 1.5 percent organic matter, 40 pounds per acre of available P_2O_5, and 100 pounds per acre of K_2O. The potential site index (average height of trees at 50 years). for red pine stands on soils at this fertility level is predicted from the regression equation cal culated by Wilde, 1970:

Site index = (8.1 + 0.2 x 9 + 2.3 x 1.5 + 0.03 x 40 + 0.01 x 100) x 3.4 = 53.0 feet

This site index of 53 corresponds very closely with the actual performance of red pine planta tions on these sites, which yield an average annual height growth of approximately 13 inches and a volume increment of 0.7 cords per acre.

Analyses of very similar sandy soils of glacial outwash in the fog belt of Lake Superior revealed an essentially different soil-forest relationship. According to the applicable equation, sandy soils of this lake shore zone have a potential site index of 53. Actually, these soils support red pine plantations yielding an annual average height growth above DBH exceeding 20 inches with a corresponding site index of 70 and an annual increment of nearly 1.4 cords per acre. As explained by the following discussion, this dramatic performance of forest stands on relatively poor soils is prompted by the increased moisture supply and the correla-

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tive extension of the growing season.

The active growth of forest stands on sandy soils of central Wisconsin, as determined by ring dendrometers (De Vries and Wilde, 1962), ceases during the first half of July, often in the first week of the month, following the exhaustion of the winter-stored water. It is true that the soils in question still contain 3 to 4 percent moisture at this time. However, determinations made either on soil samples or directly by the neutron-scattering probe, provide only a first approximation of the critical supply of soil water. Forest plantations and stands of advanced age only sparingly saturate the soils with their root systems. Consequently, a large percentage of analytically detectable water is located in the interrhizal spaces and is not accessible to roots because of a too limited or too slow capillary transfer.

An entirely different picture of the water regime is observed along the shores of Lake Superior. The high humidity of this belt, coupled with wide extremes between day and nighttime temperatures, creates conditions like those on the inside of a refrigerator door opened in a warm kitchen. Condensation of vapor on the cooler surfaces of the soil and tree foliage continues during the entire summer and particularly during rain-free periods with their hot days and cool nights. As shown by ring dendrometer recordings, this non-measurable precipitation sustains the active growth of trees into late August. Thus, contrary to predictions based solely on temperature, the "picetum" belt of northern Wisconsin under the influence of moisture has almost twice as long a growing season as the "fagetum" or "aceretum" areas of the State.

The statistical relationship of soils and forest growth for the uplands of the Lake Superior fog belt is approximated by the equation $h = 1.3\ h_o$, where h is the average height increment of stands on soils of the Lake Superior shore, and h_o is the height increment of stands on soils in continental parts of Wisconsin. The same formula with proper adjustment of the coefficient is applicable to stands supported by naturally subirrigated soils, i.e., soils underlain at various depths by ground water with the capillary fringe of different extensions. For most Wisconsin plantations, benefited by ground water at a depth of 4 to 7 feet, the coefficient varies within the narrow range of 1.2 and 1.4.

Cursory observations of red pine plantations in southern Indiana suggest that for soils of comparable fertility to Wisconsin's, the climatic coefficient is about 1.5, a result induced largely by the distribution of rainfall and a growing season of almost 6 months. In brief, neither the concept of soil fertility nor the concept of the growing season is significant if isolated from the entire complex of environmental influences.

One practical value resulting from the intermittent influence of either condensed vapor or pulsating ground water on forest trees is that they produce wood of appreciably higher specific gravity than trees growing without the benefit of either atmospheric or subterranean moisture. The reason appears to be the periodic but prolonged inflow of small amounts of moisture which perpetuate the formation of summer wood, a process cardinally different from that resulting from artificial watering of forest stands (Wilde et al., 1951; Maeglin, 1966).

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