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Growth of Trembling Aspen in Relation to Ground Water and Soil Organic Matter

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Growth of Trembling Aspen in Relation to Ground Water and Soil Organic Matter[1]

S. A. WILDE and D. T. PRONIN[2]

BEFORE the advent of the white man, the poorly drained sandy soils of central Wisconsin supported valuable stands of white pine. During the past 100 years, however, these soils have undergone drastic depletion caused by clear-cut logging, repeated fires, artificial drainage, cultivation, and grazing. By and large, the

TABLE 1.—*Comparison of the nomograph values with actual rate of growth of well-stocked stands of trembling aspen as determined on sample plots.*

Sample plot No.	Depth to ground water table Ins.	Content of org. matter %	Av. age of stand Yrs.	Av. DBH Ins.	Av. ht. Ft.	Av. annual ht. growth Ins/yr.	Estimated av. annual ht. growth Ins/yr.	Deviation of estimated values Ins.	Error %
1	21	2.8	20.0	4.0	36.6	21.9	20.0	—1.9	8.7
2	20	2.5	23.2	4.5	42.4	21.9	19.0	—2.9	13.2
3	19	3.5	25.2	5.3	46.6	22.2	19.0	—3.2	14.4
4	32	3.6	27.0	5.7	62.6	24.1	22.5	—1.6	6.6
5	52	4.2	27.8	5.0	46.1	19.9	19.0	—0.9	4.5
6	38	3.3	24.0	4.6	38.6	19.3	20.5	+1.2	6.2
7	37	2.7	27.4	4.5	43.6	19.1	20.5	+1.4	7.3
8	20	3.1	23.8	3.8	38.6	19.5	20.0	+0.5	2.6
9	28	1.5	23.6	2.6	31.0	15.8	15.0	—0.8	5.0
10	60+	1.7	40.8	5.3	54.4	13.5	12.5	—1.0	7.3
11	36	2.7	23.2	4.1	32.8	17.0	21.5	+4.5	26.5
12	48	3.2	25.0	4.8	46.0	22.1	19.5	—2.6	11.8
13	30	3.7	27.3	5.7	54.6	24.0	23.0	—1.0	4.2
14	36	5.6	25.6	5.4	40.2	23.5	22.5	—1.0	4.3
15	16	2.8	26.8	3.2	32.1	14.2	16.0	+1.8	14.0
16	24	2.7	24.0	4.9	40.8	20.4	21.5	+1.1	5.4
17	60	2.1	30.3	5.2	42.4	16.0	16.5	+0.5	3.0
18	24	3.7	21.5	4.6	38.7	23.4	22.0	—1.4	6.4

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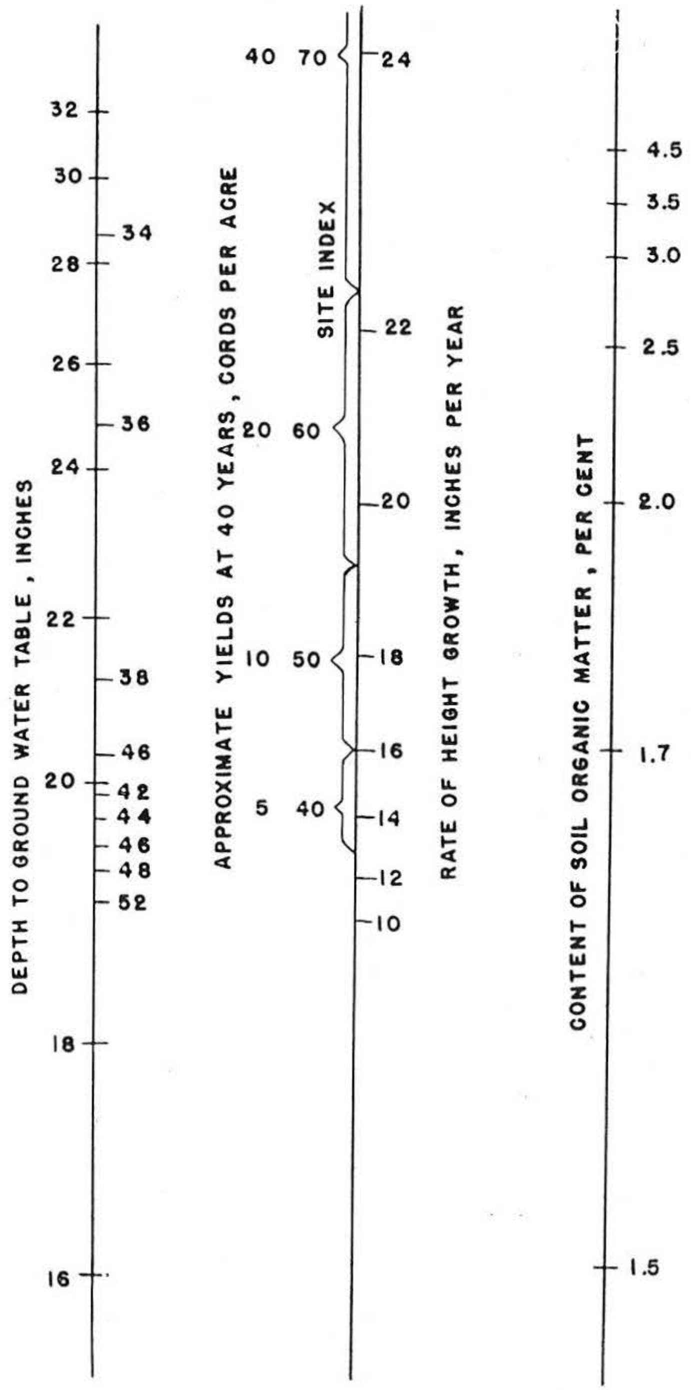

FIG. 1.—Nomograph expressing the relationship between the rate of growth of semimature (20 to 27 years) trembling aspen, depth of ground water table (upper limits of gley horizon), and content of soil organic matter (7-inch layer) in quartz sands of central Wisconsin.

soils of this region are derived from highly siliceous material, and adverse influences reduced their nutrient content to mere traces.

Paradoxically, the depletion of soils in central Wisconsin has created substrata of unique ecological interest. The growth of young forest stands on extensive areas of siliceous gley sands is influenced largely by two factors: ground water table and content of soil organic matter. Such conditions provide a rather unusual opportunity to observe the relationship between forest growth and composition of soil unobscured by the co-influence of many factors.

An attempt to express in concrete figures a correlation between the rate of growth of trembling aspen, content of soil organic matter, and depth to the ground water table was made during the summer of 1947 (3, 4). The rate of growth of trembling aspen was determined on 22 sample plots varying in size from 1/5 to ½ of an acre. The age of the aspen stands ranged from 22 to 27 years. The present and the expected yields were determined on the basis of available tables (1). The depth to the upper limits of the deoxidized zone (gley horizon), indicating the prevailing position of the ground water table, was established on each sample plot. Samples were collected from the 7-inch surface layer of soil by means of a sampling tube and were analyzed for their content of organic matter, using a rapid colorimetric procedure (2).

The results obtained are incorporated in the attached nomograph, constructed on a pattern of logarithmic curves by empirical trials. According to this, aspen stands on soils with the ground water table at a depth of 52 inches and an organic matter content of 2.5% show an average height growth of 18 inches per year; this corresponds to site index 50 and an expected yield of 10 cords per acre at the age of 40 years. On the other hand, aspen stands on soils with the ground water table at a depth of 36 inches and a content of organic matter of 3.5% show an average height growth of 22 inches per year; this corresponds to site index 60 and an expected yield of fully stocked stands of about 25 cords at the age of 40 years.

In the summer of 1948 the study was repeated on additional 18 one-fifth acre sample plots. The age of aspen stands included in the later survey varied within a somewhat wider range because of the scarcity of well-stocked stands of aspen. The results are presented in Table 1 which compares the actual rate of growth with that predicted on the basis of the nomograph. In 13 out of 18 instances, the error varied between 3.0 and 8.7%, which is a very high degree of accuracy for any type of growth estimate. In four cases, the difference between the estimate and actual height growth ranged from 11.8 to 14.4%; these discrepancies are appreciable, but not unreasonable if one considers the nature of second-growth aspen stands. In one instance, an error as high as 26.5% was observed, and should be attributed to the influence of factors that have no relation to soil fertility.

It should be stressed that the construction of the nomograph was based largely on the observations of stands underlain by "lean" ground waters having a reaction between pH 5.0 and pH 6.5, specific conductance of 5 to 10 mhos, and total alkalinity not exceeding 20 ppm. A considerably higher rate of growth would be expected if the ground water is enriched in nutrients through contact with lenses of lacustrine clay or other nutrient-bearing substrata (5).

Aside from the chemical composition of ground water, a number of other factors may be responsible for the discrepancy between the actual and predicted rates of stand growth. Among these, origin of the stand (seed or sprout), history of stand development (growth-retarding effects of drought and frost), and the nature of soil organic matter (peat vs. litter), should especially be mentioned.

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Structure Improvement Following Legume Growth on Unfertilized Subsoil[1]

P. W. FLETCHER and R. B. LIVINGSTON[2]

THE planting of trees is commonly recommended for the rehabilitation of eroded and abandoned lands which are no longer profitable for agriculture. Frequent planting failures or poor growth on such lands indicate that a preliminary period of site preparation is essential to the success of the tree rotation. Certain legumes may be the best solution to this problem, particularly when the more exacting species of hardwoods are to be planted.

This paper is a progress report of a continuing study, comparing the physical character of an eroded soil profile under *Lespedeza sericea* Benth. with that of an adjacent bare area.

The legume was seeded without fertilizer in 1941 by Harris and Drew (2)[3] directly on the B horizon of a Weldon silt loam (Fig. 1), exposed by road construction equipment in 1939. Despite an initial 95% mortality, due largely to winter frost heaving, the *Lespedeza sericea* stand was dense and spreading in 1949 after 8 growing seasons and no intervening attention.

The standing *Lespedeza sericea* vegetation of 4.33 tons dry weight per acre in August had a rainfall interception capacity of about 0.15 inches. The litter accumulated at the soil surface was equivalent to 7.28 tons dry weight per acre, and had a water-holding capacity of about 0.15 inches.

Soil moisture samples were taken at irregular intervals throughout the summer to a depth of 3 feet on both study plots. During the period from June 20 to July 29, when 5.95 inches of rain fell in 12 showers, soil moisture within the bare area profile remained almost unchanged below the 15-inch depth, or approximately at field capacity (Fig. 3A). The *Lespedeza sericea* plants

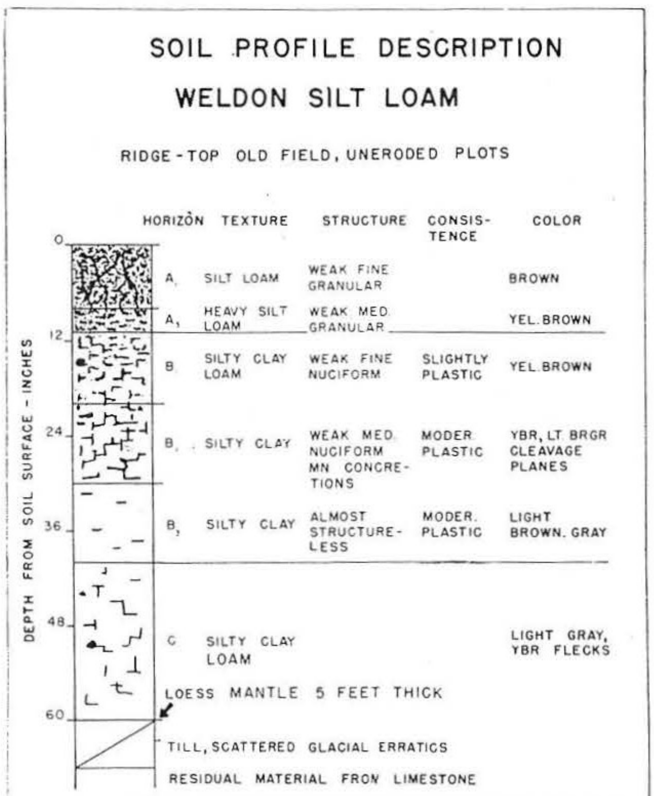

FIG. 1.—The upper 15 inches of this profile were removed artificially, exposing the B_1 horizon as the surface of the study plots.

(Fig. 2), however, definitely depleted soil moisture to a depth of 3 feet (Fig. 3B), due to the combined effects

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[3] Figures in parentheses refer to "Literature Cited", p. 350.