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THE COMPARATIVE INFLUENCE OF LEAF MOULD AND INORGANIC FERTILIZERS ON THE GROWTH OF RED OAK

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THE practice of clear cutting, formerly prevalent here, together with the numerous fires that have swept this section have had an undoubtedly injurious effect on the soil and consequently on the trees. Hot ground fires are known to burn the organic matter in a soil to a considerable depth. The destruction of this organic matter has a highly deleterious effect on moisture relations, on the animal population, both macro and micro, on the flora, and on nutrient relations. This experiment sought the effect of artificially replacing this fire-destroyed humus. This is in line with one of the chief objectives of our general silvicultural policy—that of rebuilding impoverished soils.

The area selected for this experiment was cut clean for cordwood in 1895. This operation was undoubtedly preceded by several similar treatments and, in addition, several hard fires have swept over this section. There is still some visible evidence of a fire or fires of comparatively recent date.

The experimental plots are situated to the east and west of the Secor Trail immediately after leaving the ridge between Sutherland and Sphagnum Ponds. The elevation is between 1260 and 1290 feet above sea level. The general aspect is northeast.

Red oak, chestnut oak, red maple and white oak comprise the overwood. The understory consists principally of scattered red oak, red maple, white oak and chestnut oak. Laurel, Vaccinium, Aralia and some Viburnum make up the ground cover.

Eight ¼-acre plots were installed on May 4, 1938, 4 to the west and 4 to the east of the Secor Trail. One plot on the west side of the Secor Trail received approximately 2½ tons of leaf mould, a second plot received 200 pounds of sodium nitrate, a third plot 400 pounds of sodium nitrate and a fourth 400 pounds of superphosphate. The 4 plots on the west side of the Secor Trail were given duplicate applications. All applications were carefully spread to secure even distribution. The westerly plots were planted with 2-2 white pine in the spring of 1939, using an approximate 6′ x 6′ spacing. In September, 1940, leaf samples were taken from red oaks on all 8 plots. These were air dried and ground in a Wiley Mill. Nitrogen, phosphorus and potassium analyses were made in duplicate, on samples dried at 70° C, using micro-Kjeldahl, ammonium molybdate and cobalt nitrite methods respectively. Increment cores were collected in June, 1941. Height measurements were taken on the planted pines in August, 1941 for the 1939-1940 growing seasons.

The leaves and other organic matter used had lain in one of the town reservoirs for about 2 years. This material had been scraped out and piled in an open space on the bank of the reservoir where it lay for about 8 years, subject to weather and decay processes. By 1938 most of the leaf mould had been reduced to the stage where leaf structure as such was no longer discernible. The bulk of the species comprising the mould consisted of red and chestnut oaks, red and sugar maple, and some birch, white ash, yellow poplar, black gum, and elm in the order named. The leaf mould, when applied to the plots, was carefully turned with a fork to insure that no large lumps were present.

Table I shows that internal nitrogen concentration is highest in the leaves from the leaf mould plots, second highest in the phosphate plots, while the plots receiving 400 pounds of sodium nitrate are third, and fourth in order are the plots which received 200 pounds of sodium nitrate.

Internal phosphorus concentration is highest in the leaves from the phosphate plots, followed in order by the leaf mould plots and the nitrate plots. The leaves from the two pairs of nitrate plots all have equal internal phosphorus concentrations. The highest internal potassium concentrations are found in leaves from the phosphate plots and those nitrate plots receiving 400 pounds of sodium nitrate. The internal potassium concentrations are the same for the 2 sets of plots. Second highest is the nitrate plot (200 pounds sodium nitrate), while the leaf mould plots have the lowest internal potassium concentration.

Radial growth increase was best on the leaf mould plots followed in order by the phosphate plots, nitrate plots (400 pounds sodium nitrate), and second set of nitrate plots (200 pounds sodium nitrate). The planted white pine showed no significant difference in height growth on any of the plots.

The interesting point in Table #1 is the higher internal nitrogen concentration in the leaf samples taken from the leaf mould and phosphate plots as compared to that in the leaf samples from plots receiving 200 and 400 pounds of sodium nitrate respectively. Leaves from both the leaf mould plots and the phosphate plots had higher internal phosphorus concentrations than did the leaves from the nitrate plots. Also, the average annual radial increment is largest for the leaf mould and phosphate plots. This growth appears to be closely correlated with internal nitrogen and phosphorus concentrations. Differences in internal potassium concentrations, as shown in Table I, do not seem to be large enough to exert a decisive influence on radial growth since the plots that made the best radial growth (leaf mould) have the lowest internal potassium concentrations.

Mitchell [1] has shown that the soils of the Black Rock Forest are deficient especially in phosphorus and also in nitrogen. Mitchell [2] also demonstrated that oak and maple leaves lost practically all their phosphorus when exposed for one winter. Lunt [3] has shown much the

[1] Mitchell, H. L., Pot Culture Tests of Forest Soil Fertility Black Rock Forest, Bulletin #5, 1934.

[2] Mitchell, H. L. and Finn, R. F., The Relative Feeding Power of Oaks and Maples for Soil Phosphorus. Black Rock Forest Papers, Vol. I, #2, 1935.

[3] Lunt, H. A., Effect of Weathering upon the Composition of Hardwood Leaves; Journal of Forestry XXXI, 8, December, 1933.

same results. Calcium is one element that is not easily leached from leaves. Since phosphorus is leached easily from most leaves, practically all of this element would have been lost from the leaf mould before it was applied to the plots. A large part of the nitrogen in the leaf mould was also lost through leaching. Yet leaves from the plots to which leaf mould was applied had the highest internal nitrogen concentration of the rest of the plots. Möller and Hausendorf[4] showed that pine, spruce and oak grew far better when supplied with humus than they did when supplied with inorganic fertilizers. They suggested that the effect could be explained by the fact that the humus was able to supply a continuous stream of nitrogen. This is probably part of the answer. It is also likely that conditions were made more favorable for mycorrizhae formation, along[5] with improved water relations and improved physical structure of the soil. If mycorrizhae formed they would explain the high nitrogen and phosphorus concentrations in leaves from the leaf mould plots. The high nitrogen concentration in leaf samples from the phosphate plots is difficult to explain.

It is clear, however, from Table I, that humus had a significantly more beneficial influence on the radial growth of red oak than did either the application of superphosphate or sodium nitrate.

[4] Möller, A. and Hausendorf, E., Humusstudien Ztschr. Forest Jagdw 53: 789-839, 1921.

[5] Romell, L. G., Ecological Problems of the Humus Layer in the Forest, Cornell University Agr. Exp. Sta., Memoir #170, 1935.

RED OAK

Plot Number	*Treatment*	*N% in R. O. Leaves Ave.*	*P% in R. O. Leaves Ave.*	*K% in R. O. Leaves Ave.*	*Av. Annual Radial Increment in mm.*			*Terminal Growth of W. Pine 1939-1940*
					1931-1937	*1938-1940*	*% increase*	
M1-C M10-C	2½ tons leaf mould	2.44	.21	.94	1.53	2.51	+ 64	4.70 inches
MN1-C MN10-C	200 lbs. $NaNO_3$	2.13	.19	1.00	1.07	1.15	+ 9	4.75 "
MN2-C MN20-C	400 lbs. $NaNO_3$	2.22	.19	1.02	1.27	1.56	+ 23	4.70 "
MP1-C MP10-C	400 lbs. Super-phosphate	2.29	.22	1.02	1.9	2.7	+ 42	4.75 "