RESEARCH NOTES

Research Note No. 22
November 1976

EFFECT OF FERTILIZATION ON THE TREE FORM OF SUGAR MAPLE (Acer Saccharem M.)

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EFFECT OF FERTILIZATION ON THE TREE FORM OF SUGAR MAPLE (Acer Saccharem M.)[1]

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Abstract

In a fertilizer field trial designed to study the response of unevenaged sawlog size sugar maple to multiple levels of Nitrogen, phosphorous and potassium, fertilizer additions, measurements were collected at 17.3 feet and diameter breast height for tree form response. Nitrogen, nitrogen-phosphorous, nitrogen-phosphorous-potassium had statistically better growth than control treatments at d.b.h. and at 17.3 feet. No significant differences in tree form were found between treatments. These results suggest that increases in growth at diameter breast high and 17.3 feet are generally proportional regardless of treatment.

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Introduction

The effect of fertilizers on tree growth has been the subject of numerous studies. Many investigations have reported significant responses to applications of fertilizers for hardwoods (Mustanoja, 1965; Mader, Ellis, 1973; Carmean, 1975). Some have not (Stone & Christensen, 1974). Generally these studies present data for volume, diameter, tree height or basal area as response variables to the application of fertilizers.

Starting in 1970, a fertilizer trial was set up at the Ford Forestry Center to study the growth response of unevenaged, selectively logged, sawlog size sugar maple. The objective of the study was to ascertain the response of sugar maple to ammonium nitrate, triple-super phosphate and muriate of potash alone and in various combinations.

In addition to diameter breast high measurements, (d.b.h.), data were obtained at 17.3 feet to determine any changes in tree form which would have additional effect on tree volume.

Methods

Stand & Site

On one third acre plots, ten trees of sawlog size with a potential No. 1 butt log were selected for study. The stand had been logged two years previous to the fertilizer trial. Each tree selected was checked for crown position and development, nearest neighbor competition and vigor. Basal area on the plots ranged from 120 to 140 square feet per acre.

The site is a level plain composed of soils having a loam to silt loam cap 18" thick over stoney glacial materials. Clay loam glacial till occurs at 10-12 feet below the surface. The soils on all plots were classified as Allouez loam, (Typic Haplorthods). Ammonium nitrate was used as a source of nitrogen, triple-super phosphate the source of phosphorous and muriate of potash as a source of potassium. Plots were established to test each nutrient carrier alone and in combination with each of the others. Rate of application was also varied between plots. The over-all study is composed of 26 different treatments, plus controls; and is replicated twice.

Collection and Analysis of Data

A subsample of six treatments plus controls were selected to study tree form changes. These treatments represent the midrange of nutrient carrier application rates.

Each tree within each plot was measured at diameter breast height and at 17.3 feet each year for five years. Bark thickness at 17.3 feet was also obtained at 4 points on circumference and averaged. This was to compensate for bark roughness at this point and as a check for d.b.h. bark thickness. The Mesavage and Girard form class equation was used to determine percent taper (Husch, 1963; Gevorkiantz and Olsen, 1955).

Taper was calculated for each tree within each plot as well as mean, standard deviation and growth per year. The data were subjected to analysis of variance for between treatment differences. T-tests were used to check individual within and between treatment mean differences (Sokal and Rohlf, 1969). Results were considered meaningful at the .05 level of confidence.

Results and Discussions

Diameter growth, changes in leaf color and size and leader elongation of the tree and their associated increments are commonly used as indicators of fertilizer response. Trees react to their site in a similar way. They have requirements for optimum growth and exhibit tolerance for stresses or deficiencies in the site. Unfortunately, these requirements and tolerances vary between species and even between sites. A given level of fertilizer application may be toxic to some species. Thus forest managers need basic information on fertilizer application which is properly related to species, site, and economic return. Tree volume increases are the most meaningful measure of economic response. Tree volume is a function of height and diameter adjusted for form. The most commonly used and widely accepted procedures for determining adjusted volumes by tree form in the United States is the Girard form class (Husch, 1963).

Changes in diameter either at breast height or 17.3 feet will affect the volume of the tree. An increase of one value in form class, for example 80 to 81, is equal to a three percent increase in volume (Gevorkiantz and Olsen, 1955). One implication here is that changes in form due to intensive management, such as fertilization, may necessitate changes in volume tables.

Results of this study are summarized in Table 1. With the exception of the phosphorous treatment (3#/tree), initial d.b.h.'s were found to be similar between treatments. Bark thickness was also comparatively equal between treatments at 17.3 feet and d.b.h. Thus for each treatment, diameters on the average were comparable. Growth rates should be similar and a change in growth per year was assumed to be a reflection of the fertilizer treatment.

Initial form class data between each treatment was not significantly different. However, the N-P-K treatment (4,3,3) approached significance. Nor were any significant differences noted in form class between treatments for the

TABLE 1. Summary of Plot Data for D.B.H. and Form Class. Comparisons Between Fertilizer Treatments for Uneven-Aged Sawlog Size Sugar Maple

Treatment	Carrier #'s/tree[1]	Initial d.b.h. in.	17.3 Bark Thickness in.	Tree Form: Initial % FC[3]	Tree Form: 5th. yr. % FC	Tree Form: 5 yr. average % FC	D.B.h. gr./yr. in.	17.3 gr./yr. in.	Av.% increase over controls D.B.h.	Av.% increase over controls 17.3%
Control		13.2	.6	83.5	83.8	83.7	.13	.12	0	0
Nitrogen	4	12.9	.5	85.2	84.8	85.2	.17	.14	30	17
Phosphorous	3	11.6	.5	83.7	83.7	83.7	.10	.08	-23[2]	-34
Potassium	2	14.7	.6	84.4	85.0	84.7	.12	.09	-8	-25
Nitrogen Phosphorous	3) 3)(	13.6	.5	85.6	85.6	85.6	.16	.15	23	25
Nitrogen Phosphorous	4) 3)(	14.5	.7	84.6	85.0	84.9	.12	.12	0	0
Nitrogen Phosphorous Potassium	4) 3)(3)	14.1	.6	81.8	83.2	83.0	.15	.14	15	17

1/ Nitrogen source: ammonium nitrate 33-0-0; phosphorous source, triple superphosphate 0-45-0; potassium source muriate potash 0-0-60.

2/ Negative percent is amount of growth less than controls.

3/ FC - Form Class

fifth year and five year averages. One can conclude from these data that tree form is proportional and growth is at an equal rate up the stem compared to d.b.h. growth.

Within treatment change did occur for several of the treatments. The most important is the change in form class for the N-P-K treatment (4, 3, 3). Here a 5 percent increase in volume took place due to average increase in form class from 81.8 to 83.0 (Gevorkiantz & Olsen, 1955). The difference between the first and fifth years amounted to a 4 percent increase in volume. Both were statistically significant. Most of the other treatments showed a slight increase in form class between the first and fifth year; and between the 5 year average and the initial form class. Control trees form class remained essentially the same throughout the test period.

Statistically better growth in d.b.h. was found between trees treated with nitrogen, nitrogen-phosphorous and controls. Treatment with phosphorous and potassium alone produced little or no increase in tree growth. All fertilizer treatments involving nitrogen, however, produced increase in d.b.h. growth. Nitrogen appears to be an essential nutrient for stemwood production. All treatments except controls, phosphorous and potassium resulted in increased stem growth at 17.3 feet but form class remained essentially the same throughout the measurement interval. The general overall form class values of control trees is 5 percent above the Lake States average of 78 percent for butt logs (Gevorkiantz and Olsen, 1955). Fertilized trees averaged 8 percent above the Lake States average. Ford Forestry Center hardwood management is selective logging whereby least silviculturally desirable trees are removed.

Conclusion

Results of this fertilizer trial on old growth sugar maple demonstrate a response to fertilization. Both diameter breast high and 17.3 diameters responded to fertilization. Statistically significant differences were found between diameter and 17.3 feet growth between several treatments. In this study, with the exception of those treatments involving phosphorous or potassium as individual treatments, those treatments with nitrogen fertilizer additions showed the greatest response over controls. Individual phosphorous and potassium treatments had a poorer growth response than controls. Tree age and tree size may have had an influence on the growth, or lack of growth, observed.

Although diameters at breast high increased, diameters at 17.3 increased proportionately thus maintaining the original form class. Comparison between fertilizer treatments shows that the complete nitrogen, phosphorous and potassium treatment had a significant within-treatment response. This amounted to an average volume increase of 5 percent over five years.

The magnitude of the diameter growth response between the various treatments is a clue, and perhaps indication of need, to fertilize for tree growth. The growth response to nitrogen demonstrates the potential impoverished condition of this site. Results of this study do show positive trends and the need for further work on the total response of sugar maple trees to fertilization.

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