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NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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FERTILIZING AND THINNING MAPLE POLES: PRELIMINARY RESULTS [1]

ABSTRACT:--Thinning significantly increased diameter growth of crop trees on two sites; fertilization did not. Some management implications are discussed.

OXFORD: 237.41:242:176.1 *Acer saccharum*. KEY WORDS: crop tree release, forest fertilization, intensive silviculture, forest soils.

INTRODUCTION

Success in fertilizing farm crops and the trend toward intensive silviculture have stimulated interest in increasing timber yields through fertilization. Reported here is some preliminary information on the response of hard maple (*Acer saccharum* Marsh.) to fertilization and thinning

METHODS

Design

In the spring of 1971 a combined thinning and fertilization study was begun in two fully stocked, pole-size maple stands growing in the Upper Peninsula of Michigan (table 1). A crop tree release thinning treatment was superimposed on the fertilization trial in a split plot-randomized block design. Each block consisted of 12 dominant or codominant study trees, well matched for crown size and initial d.b.h. Blocks were replicated six times on each of two sites for a total of 144 sample trees. Results for each site were evaluated separately by analysis of variance.

Study Areas

One stand is located on the Upper Peninsula Experimental Forest near Dukes, Michigan, 20 miles south of Marquette. The site is a nearly level moraine of Valders till. The soil is Munising sandy loam, a locally extensive, weakly developed spodosol (Alfic Fragiorthod) formed in well-drained acid till. The fragipan is generally 6- to 12-inches thick and occurs at about 24 inches. Although most of the roots occur in the surface 12 inches of soil, some extend below the pan. This series is locally considered a good site for northern hardwoods.

The other stand is growing on a level, well-drained till plain of medium sand near Melstrand, Michigan, about 15 miles northeast of Munising. The soil is a Typic Haplorthod (sandy mixed frigid) with weakly developed discontinuous ortstein in the B horizons. The subsoil contains fragments of highly weathered sandstone weathering to fine and very fine sand occuring in bands. Consequently, the subsoil grades to a loamy sand and maple roots are not uncommon at depths of 24 to 36 inches. The soil on this site does not match any of the recognized series but is reasonably close to a Kalkaska sand. This series is generally considered a medium site for hardwood growth.

Treatments

Half the sample trees in each block were released by cutting all competing trees with crowns within 5 to 10 feet of crop tree crowns. Each block consisted of a group of six thinned and a group of six nonthinned poles. One of the following treatments was then applied to each tree in each group:

[1] *Contribution from Michigan Agriculture Experiment Station, East Lansing, as journal article 6206; and this Station.*

Table 1.--*Stand and site characteristics of the two study areas*

Study area	Stand age	Average height	Basal area	Soil	Available nutrients			
					P	K	Ca	Mg
	Yrs.	Ft.	Sq.ft./acre	pH	Lbs./acre			
Melstrand	47	61	127	5.1	27	60	860	63
Dukes	48	65	127	4.9	35	92	960	112

Control--no treatment

N--100 lbs./acre elemental nitrogen

NP--nitrogen as above plus 100 lbs./acre P_2O_5

NK--nitrogen as above plus 100 lbs./acre K_2O

NPK--nitrogen as above plus P and K as above

3N+PK--300 lbs./acre N plus P and K as above.

The fertilizers were surface broadcast on a 0.01-acre (11.8-foot radius) plot around each study tree in early May 1971. The nutrient sources were ammonium nitrate (33 percent N), treble superphosphate (46 percent P_2O_5), and muriate of potash (60 percent K_2O).

Sampling and Measurements

Each tree was measured to the nearest 0.01 inch at 4.5 and 17.5 feet. The two measurement points were marked with paint initially and remeasured at the same points in mid-September each of the following years. Basal area was determined by measuring all trees on a 1/20-acre plot (26.3-foot radius) surrounding each study tree. On each site 6 to 10 dominant poles were felled and sectioned for height-age determinations.

A soil sample for each tree (0.01 acre) was obtained by taking 24 cores from each area for a composite sample. Available phosphorus was extracted with 0.025 N HCl plus 0.03 N NH_4F using a 1:8 soil-to-extractant ratio. Available potassium, calcium, and magnesium were extracted with neutral normal NH_4OAc using a 1:8 soil-to-extractant ratio. Phosphorus was determined colorimetrically, potassium by flame photometry, and calcium and magnesium by using an atomic absorption spectrophotometer. Soil pH was determined with a glass electrode on a 1:1 soil-to-water suspension.

RESULTS

Response to Release

Since the responses were essentially the same both years, data for the 2 years growth are combined. As expected, the larger poles tended to grow more than the smaller ones (table 2). This trend was more pronounced in the nonthinned samples and reflects the competitive advantage of the larger, dominant trees growing under dense, even-age conditions.

After thinning, however, diameter growth of the smaller poles was nearly as great as that of the larger ones. All thinned trees grew significantly faster than those not thinned; the average 2-year growth was increased from 0.22 to 0.38 inches, a stimulation of 73 percent due to thinning (table 2). The response at 17.5 feet followed essentially the same pattern but averaged 0.01 to 0.02 inch less than that at breast height.

Response to Fertilization

There was no significant response to fertilization on either site. Although not statistically significant, some of the treatments tended to depress diameter growth the first 2 years following fertilization, especially in the nonthinned poles (table 3). On the sand site, trees that received NP, NK, and NPK all grew about the same as the controls while those in the N and 3N+PK treatments grew slightly less. On the sandy loam at Dukes none of the nonthinned, fertilized trees grew as much as the controls.

Except for one treatment on each site, diameter growth of thinned and fertilized trees was about equal to or slightly less than that of those released but not fertilized. On the sand at Melstrand, NK + thinning resulted in slightly

Table 2.--*Two-year d.b.h. growth of nonthinned (NT) and thinned (T) maple poles by initial diameter class*

Study area	Initial d.b.h.								Average	
	5.5 - 5.9		6.0 - 6.4		6.5 - 6.9		7.0 - 7.4			
	NT	T	NT	T	NT	T	NT	T	NT	T
Melstrand	0.20	0.34	0.18	0.31	0.22	0.38	0.25	0.33	0.21	0.34
Dukes	.18	.42	.23	.40	.27	.43	.27	.48	.24	.42
Average	.19	.38	.20	.35	.24	.40	.26	.40	.22	.38

Table 3.--*Cumulative d.b.h. growth of thinned and nonthinned maple poles on two sites for 2 years following fertilization*

Fertilization treatment	Melstrand			Dukes		
	Nonthinned	Thinned	Mean	Nonthinned	Thinned	Mean
Control	0.22	0.36	0.29	0.27	0.44	0.36
N	.17	.33	.25	.20	.37	.29
NP	.22	.36	.29	.23	.48	.36
NK	.22	.40	.31	.23	.40	.32
NPK	.23	.32	.27	.25	.39	.32
3N+PK	.20	.30	.25	.25	.45	.35

greater growth than thinning alone, and at Dukes NP + thinning was slightly better. These responses indicate a probable thinning-fertilization interaction that, after two growing seasons, is not yet significant.

The most striking trend is the apparent depression of radial growth following surface application of ammonium nitrate. Diameter growth of both thinned and nonthinned trees was reduced, and the depression was greater on the more productive sandy loam site at Dukes. First year foliar analyses for elements other than nitrogen showed significantly greater absorption of added nutrients by fertilized trees. Field observation also revealed a typical nitrogen response--dense crowns and large, succulent, deep-green leaves indicating that at least some of the added nitrogen had been absorbed and utilized in vegetative growth. Perhaps fertilization has stimulated leaf and crown development at the expense of wood formation on the main stem, and diameter growth will be accelerated by the larger crowns later in the rotation.

DISCUSSION

Response to Fertilization

The general lack of response to fertilization was not totally unexpected. Many of the successful fertilization trials have been conducted in regions of predominantly residual soils that have been subjected to long and intense weathering (Zahner 1959), or have been cleared and farmed or otherwise depleted of one or more essential nutrients (Heiberg and White 1951). In contrast, the northern hardwood species of the Lake States tend to occupy the most productive sites where the soils have developed from fresh glacial or alluvial depositis. Moreover, studies in other regions have shown that water deficits or other environmental conditions may limit daily growth even though nutrient levels and other site factors are favorable (Zahner 1968, Waring and Youngberg 1972).

Responses to Release

The poles on both sites responded well to release. Thinning resulted in an acceleration in diameter growth of 53 percent the first year and 73 percent after two growing seasons. If this trend continues at the same rate, the released trees will have nearly doubled diameter growth by the third growing season. In fact, the released poles on the sandy loam site at Dukes grew twice the rate of the nonthinned ones the second year.

It can be assumed that the response will continue until stand density builds up to the point where root and crown competition again limit growth. Periodic cuttings can be expected to maintain superior growth of crop trees until they reach large sawlog sizes (Eyre and Zillgitt 1953).

CONCLUSION

These studies are not complete and fertilization may yet produce a growth response. At this point, however, it appears that fertility is not a significant factor limiting diameter growth on sites like these. Thinning, on the other hand, results in immediate, significant increases in tree growth. These data suggest that investments in intensive cultural practices in young northern hardwoods should begin with improvement cuttings.

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