A Sugar Maple
PLANTING STUDY
in Vermont

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A Sugar Maple PLANTING STUDY in Vermont

PAST ATTEMPTS to establish sugar maple (*Acer saccharum* Marsh.) by planting have generally met with little success. The failures have been blamed mainly on competition by other vegetation and on damage done by animals.

Finding an effective way to establish sugar maple seedlings is a key part in the research being carried on in Vermont by the USDA Forest Service to develop superior sugar maples for producing sap and sugar.

In 1964 we began a small planting study with sugar maple seedling to evaluate several methods of weed control and protection from animals. The results indicated that black plastic film used as mulch provides excellent weed control for as long as 4 years, and increases growth significantly. However, the protective treatments we tried (an animal repellent and wire screens) were not entirely effective; so the full potential of the black plastic mulch treatment was masked by damage done by repeated deer browsing.

BACKGROUND

Sensitivity of hardwood seedlings to competition from weeds and grasses has been reported by many investigators *(Schreiner 1945; Rudolph 1950; Merz and Finn 1955; Pruett and Gatherum 1961; Byrnes 1966;* and *Bjorkbom 1968)*. Seedling survival and growth are adversely influenced in several ways. The most obvious are the effects of competition for light, moisture, and nutrients. Other effects include mechanical damage resulting from snow mashing down overtopping herbaceous cover, and dense stands of weeds and grasses that provide ideal habitat for mice and rabbits.

Animal damage has been reported to be a great hazard to the success of hardwood plantings. In a survey of hardwood plantations in the Lake States, which included sugar maple, Stoeckeler and Limstrom *(1950)* found that over 80 percent of the seedlings were damaged by deer browsing. Wallihan *(1959)* summarized his analysis of northern hardwood plantations in New York by stating that the risk of serious animal damage was so great that he questioned the feasibility of continuing hardwood planting without some effective means of control.

The literature leaves little doubt that control of competing vegetation and animal damage are essential. The questions that arise are: What degree of control is required? And what are the best methods of achieving it?

METHODS & MATERIALS

The planting site selected for our study was an abandoned highland pasture, located on the Rochester Ranger District of the Green Mountain National Forest in northern Vermont. This site is situated on a 10-percent east slope at an elevation of 1,800 feet. The soil is a Calis loam — a deep, moderately well drained soil of glacial till origin.

Three weed-control treatments and three protective measures were tested. These were designed to provide a wide range of conditions, as follows:

Weed-Control Treatments

1. Control.—Planting in sod.
2. Cultivation.—Plots were prepared by plowing and disking before planting to provide a temporary relief from competing herbaceous vegetation.
3. Cultivation plus black plastic film as mulch.—Plots were prepared as in treatment 2, followed by placement of black polyethylene film (4 mils thick and 3 feet wide) over the entire plot after planting. The purpose of this treatment was to provide weed control for several years.

Protective Treatments

1. Control.—No protection.
2. Repellent.—Temporary protection was provided by dipping the seedling before planting in a commercial repellent known as Z.I.P. (active ingredients 30 percent zinc dithiocarbamate-amine complex and 10 percent polyethylene polysulfide as sticker).
3. Wire screens.—Initially, complete protection was provided by enclosing the seedlings in cylindrical 8-inch, 30-inch high screens of $\frac{1}{4}$-inch hardware cloth.

The study was designed as a split-plot experiment. Five blocks were used, each comprising three plots, each of which contained 48 seedlings (16 per subtreatment)—a total of 144 seedlings per block. The main plot treatments were weed control. Within each main plot, protection treatments were assigned at random to individual seedlings to intermix the protective treatments throughout each main plot.

Planting was done early in November 1964. The planting stock was 2-0 seedlings that ranged in height from 12 to 30 inches and average 21 inches. Seedlings were carefully hand-planted in prepared holes on a 3-x-3-foot spacing in 6 rows of 8 seedlings per row (fig. 1).

Final measurements were made early in the spring of 1969. Data were recorded on survival, stem height, stem diameter at 1 inch above the root collar, and green weight of stems clipped

Figure 1.—A study plot mulched with black plastic film. The wire screens were designed to protect the seedlings from animals.

at ½ inch above the root collar. Plot means were based on survivors; and the data were analyzed by analysis of variance for split plots.

RESULTS

Survival

Initial spring survival of the fall-planted 2-0 seedlings was found to be extremely good. Seedling losses amounted to only 2.5 percent (18 of the 720 planted).

At the end of four growing seasons, overall survival for all treatments was 91.5 percent (table 1). Statistically there were no differences in survival due to the weed-control treatments, but significant differences did occur as a result of the protective treatments. However, the difference in survival between the poorest treatment (no protection) and the best (screens) was only 9.6 percent.

Table 1.—*Average survival of sugar maple seedlings 4 years after planting under different protective and weed-control treatments*

Protection treatment	Weed-control treatment			Mean survival
	Sod	Cultivation	Cultivation and plastic mulch	
	Percent	*Percent*	*Percent*	*Percent*
No protection	95.0	86.3	80.0	87.1
Repellent	87.5	92.5	92.5	90.8
Wire screens	98.8	93.8	97.5	96.7
Mean survival	93.8	90.8	90.8	91.5

Growth

Growth differences as a result of weed control and protection, as well as their interaction, were highly significant (0.01 level). Seedlings protected by screens and planted on the plots mulched with black plastic grew best. Their average height after four growing seasons was 44 inches (fig. 2). Screen-protected seedlings planted in sod, and on the cultivated plots, averaged only 25 and 34 inches in height respectively. Little or no differences

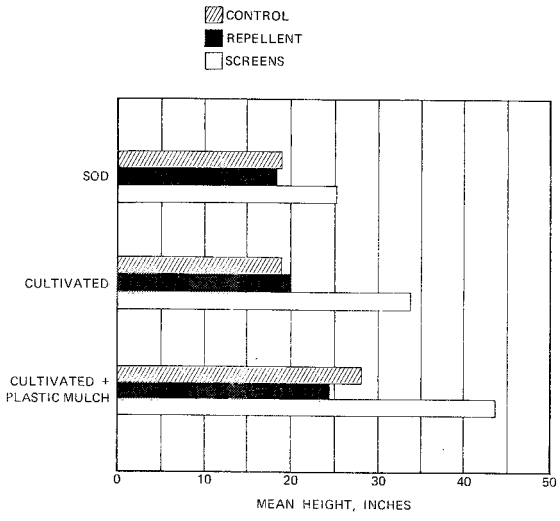

Figure 2.—Mean heights of sugar maple seedlings 4 years after planting under different protective and weed-control treatments.

were found between the unprotected and repellent-treated seedlings. They remained at essentially the same height (about 21 inches) on all plots, similar to when they were planted.

Differences in stem diameter and green stem weight, in general, followed the same pattern as differences in height growth.

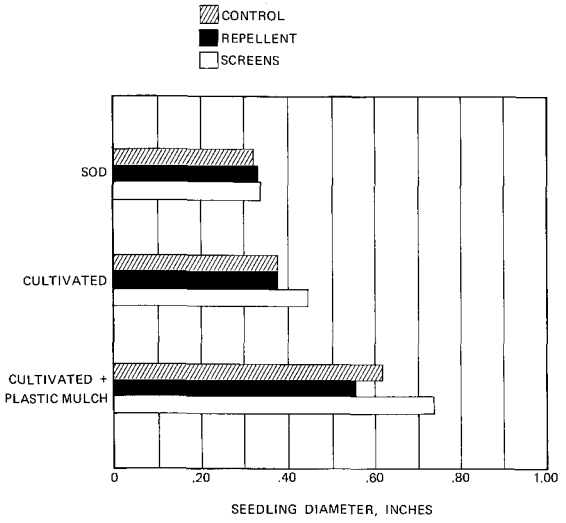

Figure 3.—Mean diameters of sugar maple seedlings 4 years after planting under different protective and weed-control treatments.

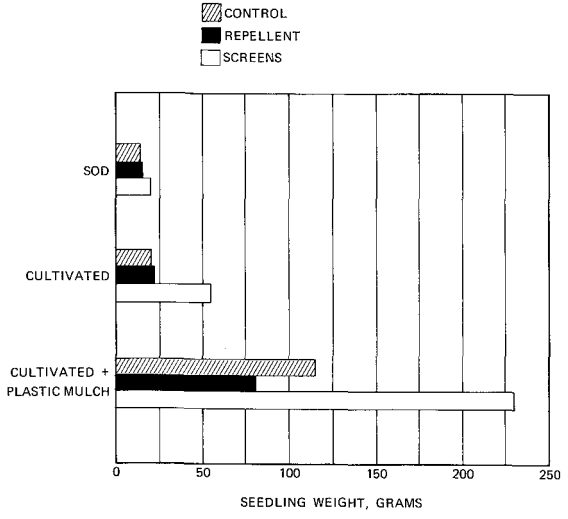

Figure 4. — Fresh stem weights of sugar maple seedlings 4 years after planting under different protective and weed-control treatments.

Stem diameters of the poorest (unprotected on sod plots) and best (screen-protected on mulched plots) treatment combinations averaged 0.32 inch and 0.75 inch respectively (fig. 3).

The greatest growth differences due to treatment, however, were in green stem weight. Average stem weights of the poorest and the best treatments were 14 grams and 206 grams respectively (fig. 4).

DISCUSSION

Survival

The initial high survival rate of 97.5 percent indicates that, if the seedlings are given reasonable care in lifting and handling, sugar maple poses no special planting problems. This study also suggests that fall planting can be done successfully. In many areas fall planting is considered risky because of frost-heaving, but none was observed in this study. Snow, which came shortly after planting and remained throughout the winter, evidently provided good protection against frost-heaving.

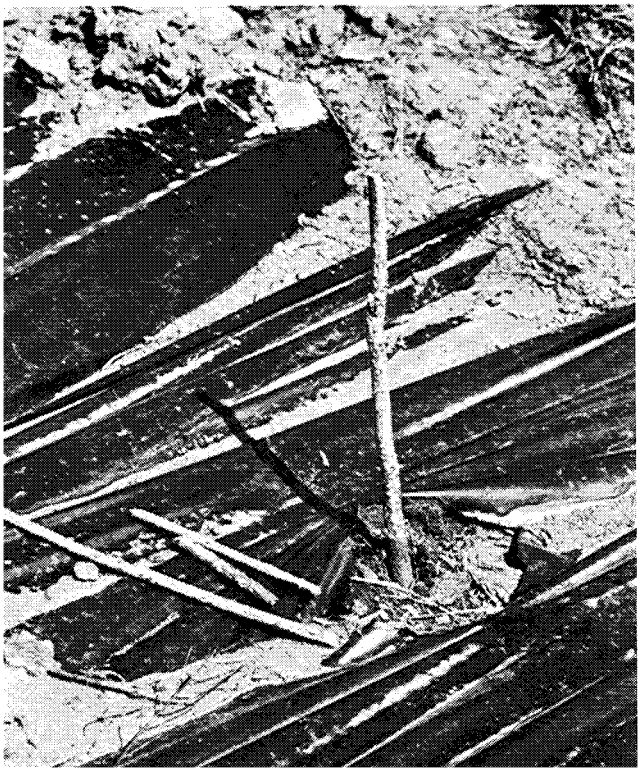

Figure 5.—Seedling completely stripped of bark by small field mammals.

Mice and rabbits were thought to be responsible for the initial mortality observed. When we made survival counts in the spring of 1965, we listed as "dead" 18 seedlings that were either missing or were stripped of bark (fig. 5). The "missing" seedlings had had their stems broken off and could not be found in the grass cover. Later, all but one of the "dead" seedlings resprouted; so in later survival counts we listed them as "live". Therefore we attributed the initial seedling losses to animal damage rather than to planting failure.

Over the 4-year study period, mortality increased slightly. The highest mortality was 20.0 percent among the unprotected seedlings planted in the plots that had been cultivated and were covered with black plastic mulch. Mortality was highest on these plots probably because the weed control, afforded by the mulch, made the seedlings more visible for browsing. The mortality for all unprotected seedlings was only 12.9 percent. Such a low

Figure 6.—Weed and grass competition on a sod plot.

Figure 7.—An example of an unprotected seedling repeatedly browsed by deer.

rate is surprising in view of the herbaceous competition on the unmulched plots and the pressure of animal feeding (fig. 6 and fig. 7).

Growth

The results of this study demonstrated the need for eliminating weed and grass competition and animal damage from sugar maple plantings. Sugar maple seedlings are very sensitive to competition from herbaceous vegetation. Growth was shown to improve in relation to the degree of weed control effected by the cultural treatments. Plots covered with black plastic film gave the best weed control, and also the best seedling growth.

Without protection from animals, however, weed control was of little benefit. These seedlings were subjected to repeated deer browsing, and after 4 years they were essentially no higher than when they were planted. The effect of browsing in repressing growth of the exposed seedlings accounts for the significant interaction between the protective and cultural treatments.

Sensitivity of sugar maple seedlings to herbaceous vegetation can be seen by comparing differences in growth between the screen-protected seedlings on both the sod and mulched plots. After four growing seasons, the screened seedlings in sod, which essentially were unbrowsed, had increased their average height by only 4 inches. On the other hand, the screen-protected seedlings mulched with black plastic had more than doubled in height, from 21 to 44 inches. But, because of heavy deer browsing after the seedlings had outgrown the 30-inch high protective screens (fig. 8), the true potential of the mulched plots was masked. Several seedlings that evidently escaped repeated browsing (fig. 9) suggest the kind of growth that may be possible. The tallest of these measured 110 inches in height—representing more than a fivefold increase over the average height at planting.

Diameter growth of the screen-protected seedlings showed similar differences as a result of the sod and mulch treatments:

Figure 8.—Seedlings were heavily deer browsed after they outgrew the 30-inch high screens.

Figure 9.—These seedlings escaped deer browsing. When the study was terminated, the tallest measured 110 inches in height.

seedlings averaged 0.34 and 0.75 inch respectively after 4 years. Treatment differences in stem weight were even more pronounced.

The average fresh weight of the screen-protected seedlings was 20 grams and 206 grams respectively on the sod and mulched plots—a difference in growth of 10 times. If the weight of the 110-inch high tree mentioned before were used to express the treatment potential in the absence of browsing, the growth ratio between the sod and mulched plots would be about 1:40.

Black plastic film effectively controlled herbaceous vegetation. Weeds were completely eliminated the first year except in the small openings around each seedling. Weeds began to appear as the plastic became torn and exposed soil, but even after 4 years it provided considerable weed control. The beneficial aspects of black plastic as a method of controlling weeds has been reported by other investigators *(Walker 1961 and Gabriel 1962)*. However, the growth advantage of the mulched seedlings cannot be attributed to effective weed control alone. Black plastic mulch was found to account for other changes in the soil environment.

Waggoner et al. *(1960)* concluded from their study that, though soil temperatures were only slightly changed, black plastic film did significantly increase available soil moisture by preventing or greatly retarding evaporation.

Eliminating competing vegetation by plowing and disking as a one-time treatment before planting significantly improved growth of the screen-protected seedlings over those planted in sod, but the advantage was short-termed. Re-invasion by weeds occurred rapidly the first year, and weeds fully occupied the plots by the end of the second year.

Except for the screen-protected seedlings planted in sod (because of poor growth they were essentially unbrowsed), all seedlings in all treatments were browsed by deer regardless of the type of protection used. Differences in effectiveness between protective treatments was a matter of timing of seedling exposure to browsing. The repellent was either totally ineffective, or its effectiveness was lost soon after planting.

The 30-inch-high wire screens, which were quite effective during the first year, proved later to be unsatisfactory because the seedlings outgrew them. The answer to deer browsing is to provide more positive protection for a longer period of time. Just how long is suggested by Pearce's *(1937)* observation on the browsing habits of deer in New York State. He concluded that seedlings are subject to deer feeding until they became at least 6 feet tall—the point he found to be beyond reach of browsing deer.

Mice and rabbit damage was found to be relatively light. When the study was terminated, approximately 20 percent of the unprotected and repellent-treated seedlings showed varying signs of basal bark feeding by mice. Only occasional clipping of lateral branches and terminals by rabbits was observed. As expected, the screened seedlings were free of this damage, except in rare instances when the screens were knocked over.

CONCLUSIONS

- The results of this study indicated that 2-0 sugar maple seedlings can be planted with reasonable assurance of high initial survival. The study further suggests that fall planting can be successful in Vermont, particularly at the higher elevations. A continuous snow cover throughout the winter, which is typical of such locations, apparently provides good protection from the dangers of frost heaving.
- Sugar maple seedlings appear to be highly sensitive to competing herbaceous vegetation, and elimination of this competition is considered essential during the first few years if rapid early growth is to be achieved. Black plastic film used as mulch was found to be highly effective for this purpose.
- Animal damage was found to be a major problem. Neither the repellent or 30-inch-high wire screens were completely effective. It is apparent that measures are needed that will provide protection until the seedlings have grown beyond the average deer-browsing height of 6 feet.

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