# *Planting* PAPER BIRCH *in Old Fields in Maine*

by John C. Bjorkbom

U. S. FOREST SERVICE RESEARCH PAPER NE-103
1968
NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
RICHARD D. LANE DIRECTOR

## The Author

JOHN C. BJORKBOM received his Bachelor of Science degree in forestry at Pennsylvania State College in 1938, and worked 3 years for the Pennsylvania Department of Forests and Waters (interrupted by military service). He joined the Northeastern Forest Experiment Station in 1948 working in forest survey in the Northeast and doing research with northern hardwoods in New Hampshire. In 1959 he was assigned to the Northeastern Station's unit at Orono, Maine, where he is studying the problems of regeneration and management of paper birch.

# *Planting* PAPER BIRCH *in Old Fields in Maine*

■

## A PROBLEM IN PLANTING HARDWOODS

PLANTING paper birch (*Betula papyrifera* Marsh.) on abandoned farmland has been suggested as a means of improving birch wood supplies for the turnery industry in Maine. However, in the past, planting hardwoods in old fields has not been very successful.

One of the reasons for this lack of success is the heavy sod cover that generally is present. The grasses that make up the sod absorb moisture more rapidly than tree seedlings, and the grasses also can endure a lower wilting point *(1)*. Thus when soil moisture supplies are low, the grasses can lie dormant, but the tree seedlings die. However, if the sod is removed, planted seedlings have time to establish their own roots so that they can compete successfully with the lower vegetation *(2)*. In addition to competing with seedlings for moisture and nutrients, sod roots have been found to act as a barrier to seedling root extension *(5)*.

In 1959, we began a study in western Maine to evaluate different treatments for reducing sod competition so that we could determine the practicality of planting paper birch in old fields.

Five birch-using companies, listed in table 1, cooperated in the study by contributing land, labor, and materials. The Soil Conservation Districts in Franklin and York counties contributed the use of tree-planting machines and a tractor.

## PLANTING SITES AND PROCEDURES

Seven plantations were established in fields typical of those found in western Maine. These fields had been pastured or mowed for hay in the past. Some had been abandoned for several years; others were in active use until taken over for this study (table 1).

The planting sites were approximately ½ acre in size. In general, the soils were well-drained sandy loams. Elevations ranged from 400 feet to 1,000 feet. The aspect was either level or southerly except on one site where the slope was to the north. All slopes were gentle.

Four treatments, each representing a different combination of site preparation, planting method, and planting position, were studied. These treatments were as follows:

- Plowed double furrow, with second slice turned over into first furrow; trees hand-planted on the second slice.
- Plowed single furrow; trees hand-planted in the bottom of the furrow.
- Scalps, 16 inches wide, done with attachments to a Lowther planting machine; trees machine-planted in center of scalped strip. (In practice, the scalps were not always full width because the blades fouled with debris.)
- No sod removal; trees machine-planted directly in the sod.

The plan called for 150 trees to be planted per treatment combination at each site, or a total of 1,050 trees per combination for the seven sites. However, because of shortages and because some gray birch was intermixed, the numbers of paper birch actually planted ran a little lower. The totals per combination ranged from 985 trees to 1,006 trees.

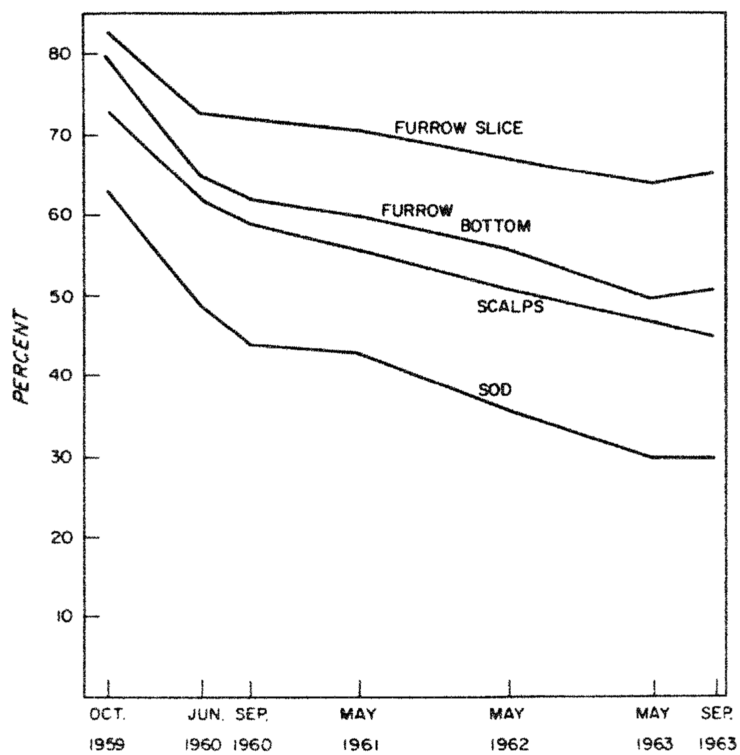
Table 1.—*Description and ownership of the plantation sites*

| Plantation | Prior land use | Sod depth | Aspect | Elevation | Soil | Drainage | Cooperator |
|---|---|---|---|---|---|---|---|
| | | *Inches* | | *Feet* | | | |
| 1 | Mowed and pastured, abandoned 5 years | 2-3 | Level | 900 | Sandy loam | Well-drained | Diamond-International Corp. |
| 2 | Last cut for hay 14 years before planting | 3 | Southeast | 900 | Sandy loam | Well-drained | Diamond-International Corp. |
| 3 | Last cut for hay 4 years before planting | 2-3 | Southwest | 1,000 | Sandy loam | Well-drained | Maine Dowel Corp. |
| 4 | Active pasture with fertility maintained | 3-4 | Southwest | 600 | Sandy loam | Well-drained | Maine Dowel Corp. |
| 5 | Active pasture until planting established | 2-3 | Level | 400 | Sandy loam | Well-drained | Forster Manufacturing Co. |
| 6 | Old pasture-inactive at least 10 years | 3 | Northeast | 900 | Sandy loam | Well-drained | C. B. Cummings & Sons |
| 7 | Mowed until planting was established | 3-4 | Level | 600 | Loam | Moderately well-drained | Saunders Brothers |

Planting was done, at approximately 6-foot spacing, during the last week in April and the first week in May. The planting stock (2-0 seedlings), grown from seed of an unknown source, was of only fair quality. Most of the finer roots had been lost when the seedlings were lifted from the nursery beds. Seedling heights ranged from as little as 1 inch to as much as 32 inches, and averaged about 9 inches.

The first seedling measurements were taken after planting in the spring of 1959. Subsequent measurements and observations were timed to coincide with the start of growth and with the time just before leaf fall. Only the spring measurements were made in 1961 and 1962. The final measurement was made in September 1963.

**Figure 1.—Trends in seedling survival by site-preparation method, October 1959-September 1963.**



# RESULTS

## Survival and Mortality

After five growing seasons, survival varied considerably within treatments among the seven plantations. But, variations notwithstanding, a definite pattern among the four treatments can be seen. Generally, survival was best on the furrow slice, better in furrow bottoms than in scalps, and always poorest in the sod.

The percent of survival by treatment and plantation is given in Table 2, and the trends in survival for all plantations combined are shown in figure 1.

Of the 3,954 seedlings planted in these seven plantations, some 2,000 died during the five growing seasons. About three-fourths of this mortality occurred in the first year after planting. The mortality was consistently heaviest among seedlings machine-planted in the sod and generally was least among seedlings planted on the furrow slice. Mortalities in furrow bottoms and in scalps, roughly equal, were in a median position. Table 3 shows the average total mortality by treatment and cause for all plantations combined.

Of the total mortality, about 12 percent was ascribed to planting failure—seedlings dying within 1 month after planting.

**Table 2.**—*Percent of seedling survival, by treatment and plantation, September 1963*

| Plantation | Treatment | | | |
|---|---|---|---|---|
| | Furrow slice | Furrow bottom | Scalps | Sod |
| | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 90 | 73 | 65 | 46 |
| 2 | 86 | 71 | 54 | 49 |
| 3 | 66 | 55 | 64 | 32 |
| 4 | 50 | 8 | 20 | 3 |
| 5 | 48 | 58 | 47 | 38 |
| 6 | 64 | 75 | 50 | 39 |
| 7 | 46 | 14 | 20 | 0 |
| Average | 65 | 51 | 45 | 30 |

Planting failure was greatest in the sod but was almost equaled by that on the furrow slice. This relatively high mortality associated with the furrow slice probably occurred because the loosened soil with its turned-under litter was especially subject to drying out.

Another 12 percent of the mortality was caused by mice. Stems were completely girdled or, in some cases, cut through. Most of this occurred during the first year after planting. Included with this mortality was a nominal amount of mortality due to rabbits and/or hares. In general, mortality caused by mice was greatest in those treatments that provided maximum cover so that mice could move with safety. Such cover was provided best by the furrow bottoms with overhanging vegetation. In one old field in which the soil fertility had been maintained, a luxuriant growth of grasses developed and provided almost perfect cover. In this particular field, mice accounted for about three-fourths of the total mortality.

Most of the mortality—76 percent—was due to other causes or to multiple causes in which the identity of the primary cause was uncertain. Included here are contributing factors such as poor root system, poor planting, dry soils, wet soils, competition from other tree seedlings, smothering by dense grass, frost heaving, damage from vehicles, and damage from deer walking in the furrows.

Table 3.—*Average mortality for all plantations by treatment and by cause, May 1959 to September 1963*

| Treatment | Total mortality | Mortality by cause | | | |
| --- | --- | --- | --- | --- | --- |
| | | Planting failure | Mice | Other | Total |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| Furrow slice | 35 | 14 | 8 | 78 | 100 |
| Furrow bottom | 49 | 9 | 21 | 70 | 100 |
| Scalps | 55 | 10 | 12 | 78 | 100 |
| Sod | 70 | 15 | 8 | 77 | 100 |
| Average | 52 | 12 | 12 | 76 | 100 |

Some seedlings simply were missing, or were not found and were presumed to be dead. Unfortunately, in most cases, the primary cause of death could not be ascertained.

### Height Growth

In general, average height after five growing seasons was greatest on the furrow slice and was progressively less in the furrow bottoms, scalps, and sod. Average height varied among plantations as well as among treatments (table 4). The heights reached in plantations 3 and 4 were substantially greater, treatment for treatment, than those in any of the other plantations.

**Table 4.—*Average height of seedlings, by treatment and plantation, September 1963***

| Plantation | Treatment | | | |
|---|---|---|---|---|
| | Furrow slice | Furrow bottom | Scalps | Sod |
| | *Inches* | *Inches* | *Inches* | *Inches* |
| 1 | 41.2 | 28.0 | 22.7 | 23.6 |
| 2 | 41.5 | 32.1 | 30.1 | 25.7 |
| 3 | 61.2 | 42.5 | 45.4 | 35.0 |
| 4 | 58.8 | 45.5 | 40.5 | 60.5 |
| 5 | 38.8 | 34.1 | 27.4 | 30.0 |
| 6 | 32.5 | 32.1 | 27.2 | 24.6 |
| 7 | 33.7 | 24.9 | 17.5 | .0 |
| Average | 43.9 | 33.2 | 30.1 | 27.6 |

We don't know why this is so. However, the soils in these two plantations appeared to be deeper and better drained and, perhaps, had higher available nutrient levels. Plantation 4 was in a field in which fertilizer had been applied by the previous user.

Mean seedling heights at the time of planting had varied slightly by treatments, as follows: furrow slice—9.4 inches, furrow bottom—9.4 inches, scalp—8.7 inches, and sod—8.2 inches. Thus, the respective amounts of 5-year height growth, derived from these figures and total heights (bottom line of table 4) were 34.5 inches, 23.8 inches, 21.4 inches, and 19.4 inches. The differences in growth among furrow bottom, scalp, and sod planting were relatively small, whereas growth on the furrow slice was 10.7 inches to 15.1 inches greater than growth on the other treatments.

## ANIMAL DAMAGE AND PROTECTIVE MEASURES

Practically all of the seedlings were damaged in one way or another during the 5-year observation period. The damage was mainly, but not entirely, caused by animals. Deer and mice were responsible for one-half of the total incidence of damage, and about one-third of the damage was due to unknown causes. The rest of the damage came from insects, rabbits, hares, frost heaving, and snow.

Deer browsing was most common on seedlings planted on the furrow slices and in the furrow bottoms. Presumably the greater height of these seedlings made them easier to see and to browse. Also, the more rapid growth of these seedlings perhaps made them more succulent and palatable.

Damage from mice was also greatest on the seedlings planted on the furrow slices and in the furrow bottoms—situations that appeared to provide the mice with maximum protection from predators.

Because animals caused much damage to the seedlings, we conducted a study on animal repellents that protect seedlings against deer, rabbits, and hares. And we also tried direct measures to reduce mouse populations.

The study plan called for trials of four animal repellents: Arasan, Diamond L, Z.I.P., and lime paste. These were applied shortly after planting and again in the fall, and applications were repeated in the spring and fall in subsequent years. Besides providing a comparison of the efficacy of the different preparations, we hoped that at least some of the repellents would reduce deer and mouse damage sufficiently to permit the effects of the planting treatments to be fully expressed in seedling growth.

However, all the repellents as used in these trials were ineffective. The long intervals between applications, plus the relatively high animal pressure on the plantation areas, mainly accounted for the poor results.

Frequency of application is important for two reasons. The first relates to the new growth of the planted seedlings. An early spring application of a taste repellent does not protect the new growth as it develops. Therefore, to be most effective, the repellent would have to be applied frequently enough to keep the new growth covered. Second, repellents undergo a weathering action after application, and consequently must be renewed as the occasion demands. The addition of so-called "stickers" to repellents before application slows the weathering action but is not completely effective.

The evaluation of animal pressure is more elusive. Pressure depends not only on the animal population at the moment but also on the amount and availability of preferred foods and other natural foods, on the abundance of predators and on their hunting success, and on other animals competing for the same food and shelter. However, we do know that the pressure—both from deer and from mice—was high enough in our plantations to cause severe damage.

In September 1960, a mouse control program in which poisoned baits were used was initiated by the Division of Wildlife Services of the U. S. Department of the Interior. This program was designed to minimize seedling damage and mortality by reducing the mouse population. The same program was followed again in the fall of 1961. Censuses made before and after treatment indicated that the procedure was extremely effective. No mortality of other wildlife was observed.

But the real effect of the control program is hard to assess. Seedling mortality and damage already had begun to decrease before the first treatment. The mouse populations on the plantations were reported to be very low at the time of the second treatment. And there is no way of knowing whether the reduction in seedling mortality and damage was due to the control program, to a natural decline in mouse population, to some other factor, or to a combination of several factors working together. Yet in spite of the inconclusive results, this type of control shows some promise.

## DISCUSSION

The results of this study show that survival and growth of paper birch seedlings planted in old-field sites are far better when the sod cover is removed than when it is left intact. The method of removal is of little importance except as associated with width of de-sodded strip, or with some other change in the micro-environment. Among our treatments, the loosened soil of the second slice of a double furrow, although relatively unfavorable for initial survival, definitely produced the best growth in seedlings that did survive the first critical weeks after planting.

There are a number of factors other than planting-site preparation that might have a pronounced effect on seedling survival and growth. Among these are the site itself, the quality of the planting stock, the quality of the planting job, the amount of animal damage, and the aftercare of the planted seedlings. However, this study was set up to measure only the effects of site preparation and, secondarily, to measure the effects of certain animal repellents. Other factors were not measured or analyzed.

The sites in this study were selected to be representative of old fields in western Maine, and they were considered favorable for growing paper birch. Except perhaps for those sites that tended to be dry, it is doubtful that the planting site itself had a great influence on survival. Warmer-than-average temperatures and considerably less-than-average precipitation in the month immediately after planting *(6)* may have caused an above-average mortality on the naturally dryer sites.

However, site did seem to influence growth. The better height growth reported for two plantations is believed to be due more to site than to any other factor. Both plantations were situated on upper slopes where good drainage might to expected. Both sites supported a dense growth of grasses, indicating higher-than-average nutrient levels; in fact, one of the plantations was a field in which soil fertility had been artificially maintained. None of the other plantations quite met this description. The inference is, of course, that the physical and chemical characteristics of the soils were more favorable for paper birch on these two sites.

The quality of the planting stock may have contributed to low survival and to reduced or delayed growth. At the time of planting, we observed that the root systems of many of the seedlings had lost most of the fine rootlets. Also, some seedlings were too small to meet accepted standards for field planting stock. Planting only those seedlings that are at least 6 inches tall and that have well-branched, fibrous root systems should appreciably increase both survival and growth.

The planting method and the care with which it is carried out might also affect survival and growth. The center-hole method, using a mattock, was specified for the hand planting, but different crews of varying experience worked at the different places. Some poor planting, with roots bent and folded, doubtless was done. The machine planting compressed the roots in one plane, and the quality of this planting probably varied with respect to depth and positioning of the trees. Root distortion and compression in one plane sometimes adversely affect survival and growth *(3)*, but the manifestation of these adverse effects may be delayed *(4)*.

Despite the difficulties encountered and the less-than-complete success in the study plantations, there are indications that successful plantings of paper birch can be made. The isolated examples of high survival and good growth provide some basis for this belief. However, certain conditions must be met. Among these conditions are deep, moist, well-drained, reasonably fertile soils; good planting stock; removal of sod cover within a space of 1.5 feet to 2 feet around the trees; careful planting; and protection from animal damage. If these conditions are met, the chances for success should be reasonably good.

If, in addition to the above conditions, after-care were provided to control the grass and the other competition around the trees, the chances for a high degree of success should be much greater. Although no after-care was provided in our study, we did observe the deleterious effects of the vegetation that developed after