Proceedings of the SYMPOSIUM ON INTENSIVE CULTURE OF NORTHERN FOREST TYPES

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FOREWORD

THE NORTHERN FOREST TYPES constitute a vast natural resource for the United States and Canada. For instance, in the eastern United States there are more than 10 million acres of commercial forest land supporting spruce and fir types alone. The magnitude and variety of this resource is such that treating it in any detail at a 3-day meeting was impossible. Rather, the idea that germinated and developed into this symposium was to present a broad picture of the extent of our knowledge of intensive cultural techniques, the status and trends of our research in the northern forest types, and some actual experiences in managing this resource; and to explore those factors that affect our use of the intensive cultural techniques we have at hand.

There is no doubt that we face a new era in the management of northern forests. The production of wood products is no longer the primary objective of many owners, and increased pressure for the social values of our forests is being felt by all landowners. We must recognize these other forest values, which in turn dictates intensification of all aspects of forest management if we are to meet the future demands of a wood-hungry society.

The enthusiastic efforts of the symposium sponsors—the School of Forest Resources, University of Maine; the Maine Bureau of Forestry; the Maine Forest Products Council; and the U.S.D.A. Forest Service—and the individuals behind those efforts, should be commended. Special thanks are due to Great Northern Nekoosa, Inc., and Brooks B. Mills for their help in providing interesting field trips, and to the Casco Bank and Trust Co. for sponsoring the symposium brochure. Also, without the enthusiastic participation of the experts invited to present papers, and the moderators of each session, the Symposium could not have taken place.

—BARTON M. BLUM
Symposium Chairman

PUBLISHER'S NOTE

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held 20-22 July 1976 at Nutting Hall, University of Maine, at Orono.

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HARDWOOD PLANTING IN SOUTHERN ONTARIO

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ABSTRACT

Successful hardwood afforestation is possible provided the following conditions can be met: (1) a deep, moist but well-drained soil; (2) intensive site preparation, preferably plowing and disking of the total plantation area; (3) careful planting of healthy, sturdy planting stock; (4) effective weed control for at least the first two and preferably three years after planting; and (5) control of rabbits and mice.

INTRODUCTION

Most hardwood species can be planted successfully provided the proper conditions are met. However, many hardwood species are very exacting in their climatic and site requirements and require intensive cultivation during the early years after planting. Therefore, successful hardwood establishment is generally more difficult and certainly more expensive than planting of coniferous trees.

In the past, hardwood plantations have often failed because foresters and tree planters had insufficient knowledge of the site requirements of the various species, and planting techniques developed for planting conifers have proved to be unsuitable for hardwood planting.

Although our knowledge of the factors affecting hardwood establishment and growth is still rather limited, sufficient information is available now to recommend hardwood planting if the following conditions are met.

SELECTION OF THE PLANTING SITE

The most important factor in establishing hardwood plantations is the selection of a suitable planting site (von Althen 1964). For satisfactory establishment and growth, hardwood species demand a deep, fertile, moist but well-drained soil, and

even land that may produce fair farm crops is not always suited to good hardwood growth. In southern Ontario, good hardwood sites will usually be found along creeks and streams, on lower slopes and in depressions where topsoil has accumulated, in abandoned orchards or gardens, and in agricultural fields where the A and B horizons are at least 18 in. (45.72 cm) deep (von Althen 1972). Hardwoods will never produce high-quality timber when planted on dry, exposed slopes and ridges, or in areas where the topsoil is shallow and the subsoil consists of heavy compacted clay.

Since sites for afforestation are generally available only because the land is unsuitable for agriculture, it would be unrealistic to envision the establishment of large hardwood plantations. At the same time, most available afforestation sites contain some small areas that are capable of growning high-quality hardwood timber. These are the sites on which hardwoods should be planted.

SITE PREPARATION AND WEED CONTROL

The second most important factor in successful hardwood plantation establishment and early growth of seedlings is the control of herbaceous competition. Since the effectiveness of weed control during the first few years after planting depends largely on the intensity of site preparation, the most intensively prepared sites will generally require the least post-planting weed control. If Princep[1] is used in post-planting weed control, site preparation is especially important for the successful establishment of those hardwood species that are highly susceptible to Princep damage at dosages necessary for the effective control of deep-rooted perennial weeds. For example, to control goldenrod (Solidago spp.), wild aster (Aster spp.) and other deep-rooted weeds effectively, applications of 4-8 lb per acre (4.8-8.96 kg/ha) of active Princep are required. However, cottonwood (Populus deltoides Bartr.) and white ash (Fraxinus americana L.) seedlings may be damaged by applications of more than 3 lb of active Princep per acre (3.36 kg/ha). Therefore, if the deep-rooted perennial weeds are not eliminated before the trees are planted it is very difficult, if not impossible, to control them after planting. However, once the perennial weeds have been eliminated by site preparation, an annual application of 3 lb per acre (3.36 kg/ha) of active Princep will generally prevent re-establishment or at least keep weed competition to an acceptable level (von Althen 1976).

Site preparation may take the form of plowing and disking or chemical eradication of the competing vegetation. The choice of method will depend on the condition of the soil, topography and accessibility, density and composition of the existing cover, and

last but not least, on the cost of the various methods under consideration. Under no circumstances, however, should the success of a plantation be sacrificed for an initial saving in the cost of site preparation and weed control.

Plowing and disking of the total plantation area is the best method of site preparation developed to date because it offers advantages not obtainable by any other method: it destroys all weeds, including the deep-rooted perennial species; it stimulates microbial activity; it loosens the soil and improves aeration and water infiltration; and it incorporates plant material into the soil, thereby improving the nutrient status and organic content of the soil.

Where plowing and disking of the total plantation are not feasible or desirable because the soil may be subject to erosion or the planting site may be partially treed, strips at least 6 ft (182.88 cm) in width may be plowed and disked, rototilled, or sprayed with herbicides, and the trees planted along the middle of these strips. However, site preparation in strips generally is less effective in promoting tree growth than is complete mechanical site preparation. The latter should, therefore, be used wherever possible.

Post-planting weed control for the first two or three years after planting is an absolute necessity for successful hardwood afforestation. Manual and mechanical methods of weed control have proven very successful but the frequency of operations required for effective control makes these methods rather expensive. Herbicides offer more economical control, but many hardwood species are highly susceptible to damage by the dosages necessary for effective control. Although many herbicides are currently available and new chemicals are marketed every year, Princep remains one of the most useful and reliable herbicides in hardwood afforestation.

Each tree species has its own herbicide tolerance. This tolerance is modified by the texture and moisture of the planting soil, seedling age, length of establishment, and time and method of application. To provide the best possible weed control without causing seedling damage, all dosages must therefore be carefully metered. A preliminary guide to the application of Princep in hardwood plantations is listed in Table 1.

Quackgrass (Agropyron repens [L] Beauv.) is one of the most competitive weeds and its elimination by mechanical means generally requires several years of intensive cultivation. Recently Rohm and Haas have marketed the herbicide "Kerb" which effectively kills all grasses including quackgrass. Kerb is very selective in its action. If applied properly it will kill grasses but will not kill or harm either trees or broad-leaved weeds. It may

Table 1. Preliminary guide to applying active Princep in hardwood plantations established on fully cultivated, former agricultural land

Species	Soil texture	Maximum allowable application of active Princep[a]	
		Shortly after planting (lb/acre)[b]	In the spring of the 2nd and 3rd years (lb/acre)[b]
Black walnut (*Juglans nigra* L.)	loam	6	4
	clay-loam	8	4
Butternut (*Juglans cinerea* L.)	loam	6	4
	clay-loam	6	4
Silver maple (*Acer saccharinum* L.)	loam	4	3
	clay-loam	5	3
	clay	6	3
Black-locust (*Robinia pseudoacacia* L.)	loam	4	3
	clay-loam	5	3
	clay	6	3
White ash (*Fraxinus americana* L.)	loam	3	3
	clay-loam	3	3
	clay	3	3
Basswood (*Tilia americana* L.)	sand	4	3
	loam	4	3
	clay-loam	5	3
Red oak (*Quercus rubra* L.)	sand	5	3
	loam	6	3
Black cherry (*Prunus serotina* Ehrh.)	sand	3	3
	loam	3	3
Sugar maple (*Acer saccharum* Marsh.)	sand	2	2
	loam	2	2

[a] Commercial grade of Princep (simazine) is available at 50 and 80 percent active chemical.

[b] 1 lb/acre = 1.12 kg/ha.

Note: 1 lb active Princep = 2 lb Princep 50W.
1 lb active Princep = 1.25 lb Princep 80W.

therefore be broadcast over the trees, like Princep, without shielding the trees or directing the spray away from them. In our experiments 1.5–2.0 lb/acre (1.68–2.24 kg/ha) of active Kerb, applied in November, killed 95% of all grasses during the winter. As a site preparation treatment, Kerb should be broadcast over the total area in late October or early November. Treated areas may include both plowed and disked land containing quackgrass rhizomes which will sprout again, and grassy fields or pastures which have not been plowed.

PLANTING STOCK

The success of any plantation will also depend on the quality and suitability of the planting stock. Good planting stock should be sturdy and have a well-branched root system (Limstrom 1963). In a study of the quality of hardwood planting stock, seedling size was much more important than seedling age (von Althen 1969). Not only did the largest trees of either 1+0 or 2+0 seedlings always grow faster than the smaller trees, but the 1+0 seedlings with large root-collar diameters generally survived and grew better than 2+0 seedlings of equal size. Table 2 lists recommendations for planting stock grades for the most commonly planted hardwood species in Ontario. Tree planters have often

Table 2. Recommended planting stock grades for hardwoods planted in Ontario

Species	Length of stem		Root-collar diameter	
	Minimum (in.)[a]	Preferred (in.)[a]	Minimum (in.)[a]	Preferred (in.)[a]
Silver maple	8	12	0.20	0.25
Basswood	8	12	0.20	0.25
Red oak	8	12	0.20	0.25
White ash	8	12	0.20	0.25
Black walnut	8	12	0.25	0.35

[a] 1 in. = 2.54 cm.

expressed a preference for large transplant stock, believing that planting large trees would eliminate the need for site preparation and weed control. Although this probably is true for individual,

large trees, those 3-4 ft (91.44-121.92 cm) high and up to five years old grew very poorly when planted in a weed-infested soil without prior site preparation or without subsequent weed control (von Althen 1974). Since transplant stock is very expensive to produce, transport and plant, and since growth of seedlings on unprepared sites is generally inferior to that of seedlings planted in plowed and disked soils treated with herbicides, it is much more economical to spend the available money on site preparation and weed control than on producing large transplant stock.

PLANTING METHODS

Small hardwood seedlings may be planted either with a planting machine or by hand using the wedge method, while large trees with spreading root systems are most efficiently planted in holes made with a posthole auger. Care must always be taken that the trees are planted at normal depth and that the soil is well packed around the roots. All trees should be planted in an upright position since leaning hardwood seedlings often develop a new vertical shoot from the root collar, necessitating the removal of the original stem by pruning and thereby losing valuable height increment (Erdmann 1966).

DIRECT SEEDING

Establishing hardwoods by direct seeding has been investigated as an alternative method to planting of nursery-grown stock. Advantages of direct seeding over planting are reduced planting costs and elimination of planting injury. The greatest disadvantage is the uncertainty of satisfactory establishment. Hardwood species with relatively small seeds such as ash and birch were generally found to be unsuitable for direct seeding and only the oaks and black walnut showed any promise of success (Winch 1937, Scholz 1964, Bjorkbom 1969). Until more successful seeding methods are developed, planting nursery-grown seedlings guarantees better plantation establishment than does direct seeding.

FERTILIZATION

Since low fertility is one of the characteristics of land withdrawn from agriculture, fertilization appears to offer possibilities of improving tree growth on nutrient-deficient sites. Although Mitchell and Chandler (1939) showed that growth of hardwood stands could be improved significantly by nitrogen fertilization, the growth response of hardwood seedlings to fertilization at time of planting has often been disappointing (Cummings 1941, McComb 1949, Burke and Williams 1973, Geyer 1974). The failure of fertilization at time of planting to improve seedling growth significantly was probably the result of one or more of

the following conditions: (1) the planting soils contained a sufficient supply of available nutrients to satisfy the nutrient requirements of the newly planted seedlings; (2) the applied fertilizer either did not reach the roots or was not taken up by the seedlings; (3) the dosages of fertilizer applied were too small to produce measurable growth responses; (4) soil physical conditions, e.g., poor drainage, were limiting growth; and (5) a deficiency in nutrients other than those applied was more limiting to seedling growth than was the deficiency in the applied nutrients.

Until more information is available, fertilization at the time of planting is inadvisable because it may do more harm than good by increasing weed competition and adding to the pollution of rivers and lakes. Fertilization is also expensive and money spent on fertilizer applications at the time of planting could be put to better use by intensifying site preparation and weed control treatments which have proven beneficial to hardwood plantation establishment and seedling growth.

RODENT CONTROL

Tree girdling by mice and browsing by rabbits can cause heavy damage in hardwood plantations (von Althen 1971). The most common method of mouse control has been the broadcast application of poisoned grain. However, this method generally provides only short-term relief. Recently, Radvanyi (1974) developed a mouse poison feeder station which provides longer lasting control. Control of rabbit browsing may be obtained by painting repellents on the trees. However, these methods are rather expensive for the degree of protection they afford. The best protection against rodent damage is the elimination of weeds; this deprives the animals of shelter and food and makes the plantation a hostile environment for rodent survival and reproduction. Also, weed control generally increases seedling growth, and fast-growing trees are less vulnerable to rodent damage because they soon outgrow the danger.

SUMMARY

The requirements for successful hardwood plantation establishment are:

1. a deep, moist but well-drained planting soil
2. plowing and disking the total area
3. healthy, sturdy planting stock
4. careful planting
5. effective weed control for the first two or three years after planting
6. rodent control where necessary

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FOOTNOTE

[1] Identification of commercial products is for information only, and does not constitute endorsement by the Great Lakes Forest Research Centre.