PRELIMINARY GUIDE TO HARDWOOD PLANTING IN SOUTHERN ONTARIO

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Frontispiece. Four-year-old white ash plantation.

ABSTRACT

Hardwood afforestation is recommended in southern Ontario as long as the following conditions can be met: (1) a deep, moist but well-drained planting 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 2 years after planting and (5) control of rabbits and mice. Fertilization is recommended on nutrient-deficient soils. Hardwood plantation establishment under average conditions is estimated to cost $110. per acre.

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INTRODUCTION

The history of hardwood planting in Ontario is characterized by periods of great interest and numerous plantation attempts, alternating with periods of total disenchantment and drastic curtailment of planting. The earliest recorded plantings, consisting mainly of windbreaks or small plantations around farms and homesteads, were carried out around 1880. No sustained planting was carried out until the early 1930's; but for approximately 15 years following 1935, an average of two million hardwood seedlings and cuttings were planted annually in southern Ontario (von Althen 1965).

The apparent failure of many hardwood plantations compared to the usually more successful coniferous plantings resulted in the curtailment of hardwood planting stock production in the provincial nurseries and few hardwood plantations were established between 1952 and 1965. Since 1965, interest in hardwood planting has increased once more, owing mainly to the growing appreciation of environmental and aesthetic values and in response to the ravages of the Dutch elm disease.

Although our knowledge of the factors affecting hardwood growth is still rather limited, sufficient information is currently available to recommend hardwood planting as long as the following conditions are met.

SELECTION OF THE PLANTING SITE

The most important single factor in establishing successful hardwood plantations is the selection of a suitable planting site (von Althen 1964). Good hardwood plantations are more difficult to produce than good softwood plantations, because most hardwood species are very demanding in their growth requirements (Mitchell and Chandler 1939). For satisfactory 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 for 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 inches deep. Hardwoods will *never* produce high-quality timber when planted on dry, exposed slopes and ridges nor in areas where the topsoil is shallow and the subsoil consists of heavy compacted clay.

Since most afforestation sites in southern Ontario are available only because the land is unsuited for agriculture, it would be unrealistic to envision the establishment of large hardwood planta-

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tions. At the same time, most available afforestation sites contain some small areas that are perfectly capable of growing good hardwood timber. These are the sites on which hardwoods should be planted.

SITE PREPARATION

The second most important factor in hardwood plantation establishment is the preparation of the planting site. Site preparation may be in the form of plowing and disking or chemcial eradication of 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 establishment costs, because initial high costs may prove to be cheapest in the long run.

Plowing and disking of the total plantation area is by far the best method of site preparation because it offers the following 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 provides improved aeration and water infiltration; and it adds plant material which improves the nutrient status and organic content of the soil (von Althen 1971c).

In an experiment near Richmond Hill, it was found that plowing and disking was a prerequisite for successful hardwood afforestation of a weed-infested clay soil. After eight growing seasons, the respective height growth of black-locust [*Robinia pseudoacacia* L.], silver maple [*Acer saccharinum* L.] and white ash [*Fraxinus americana* L.] was 15, 10 and 10 feet on plowed land as against 5, 4 and 2 feet on scalps 18 inches in diameter (von Althen 1970; unpublished manuscript).

Complete mechanical site preparation also provides the most favorable conditions for subsequent chemical weed control because regrowth of weeds can generally be prevented by applying herbicides in dosages small enough to be tolerated by the highly susceptible hardwood seedlings.

Where plowing and disking of the total area is not feasible, strips several feet wide should be plowed and disked and the trees planted along the middle of these strips. On light-textured soils or those with few weeds, site preparation may take the form of chemical eradication of weeds on the total area or in strips at least 5 feet wide. However, these methods are generally much less effective in promoting seedling growth than complete mechanical site preparation.

Hardwood seedlings should never be planted in the bottom of furrows, because the temporary relief from competition seldom compen-

sates for the loss of growth owing to lower fertility of the subsoil, loss of the seedling's height advantage and the increased danger of flooding and frost damage (von Althen 1971c). Planting on individual scalps prepared by either mechanical or chemical methods should also be avoided, because weed control on patches smaller than 3 feet in diameter is generally insufficient to promote satisfactory seedling growth.

WEED CONTROL

The effectiveness of weed control during the first few years after planting depends largely on the intensity of site preparation, with the most intensively prepared sites requiring the least weed control (von Althen 1971b, 1972). The additional cost of intensive site preparation may, therefore, be partly or totally offset by reduced weeding costs. Manual and mechanical weed control methods have proven very successful but the frequency of operations required for effective control makes these methods rather expensive. Herbicides offer a 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 chemcials are marketed every year, simazine[1] remains one of the most useful and reliable herbicides in forestry. It is a pregermination herbicide and is taken up only through the roots. Its toxic effect is predominantly the result of interference in the photosynthetic process (Mullin 1968). Simazine may be applied at any time of the year without the necessity of shielding the tree seedlings. It is very effective in preventing new weed growth and for best results should be applied to weed-free surfaces in early spring before weed growth has started. Simazine may also be used to control established weeds, but here it is most effective in combination with such herbicides as gramoxone, amino triazole or dalapon. Use of these herbicides, however, necessitates the shielding of the trees or directing the spray away from the trees, to avoid damage.

Since each tree species has its own herbicide tolerance which is modified by the texture and moisture of the planting soil, seedling age, length of establishment and time and method of application, dosages must be carefully metered to provide the best possible weed control without causing seedling damage. A preliminary guide to the application of simazine in hardwood plantations is listed in Table 1. Simazine must be mixed well and during application needs continuous agitation in the tank to prevent settling, if correct dosages are to be achieved.

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[1] Now marketed under the trade name "Princep". Trade names are given solely for the convenience of the reader; neither endorsement of the product named nor disapproval of products not named is implied.

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]		Water	
		Shortly after planting	In the spring of the second year	Application in the--	
		lb/acre	lb/acre	1st year gal/acre	2nd year gal/acre
Black walnut	loam	6	4	50	50
	clay-loam	8	4	50	50
	clay	8	4	50	50
Silver maple	loam	4	3	50	30
	clay-loam	5	3	50	30
	clay	6	3	50	30
Black-locust	loam	4	3	50	30
	clay-loam	5	3	50	30
	clay	6	3	50	30
White ash	loam	3	3	30	30
	clay-loam	3	3	30	30
	clay	4	3	50	30
Basswood	sand	4	3	50	30
	loam	4	3	50	30
	clay-loam	5	3	50	30
Red oak	sand	6	3	50	30
	loam	6	3	50	30
Black cherry	sand	3	3	30	30
	loam	3	3	30	30

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

Note: 1 pound active Princep = 2 pounds Princep 50W
1 pound active Princep = 1.25 pounds Princep 80W

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 hardwood planting stock quality, I found that seedling size was much more important than seedling age (von Althen 1969a). 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 my recommendations for planting stock grades for the most commonly planted hardwood species in Ontario. Tree planters have often 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 holds true for the planting of individual, large trees, I found in my experiments that trees 3 to 4 feet high and up to 5 years old grew very poorly when planted in a weed-infested soil without prior site preparation or without subsequent weed control. Since transplant stock is very expensive to produce, to transport and to plant, and since growth on unprepared sites was always inferior to that of seedlings planted in plowed and disked soil and 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 (Fig. 1).

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

Species	Length of stem		Root-collar diameter	
	Minimum (in.)	Preferred (in.)	Minimum (in.)	Preferred (in.)
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

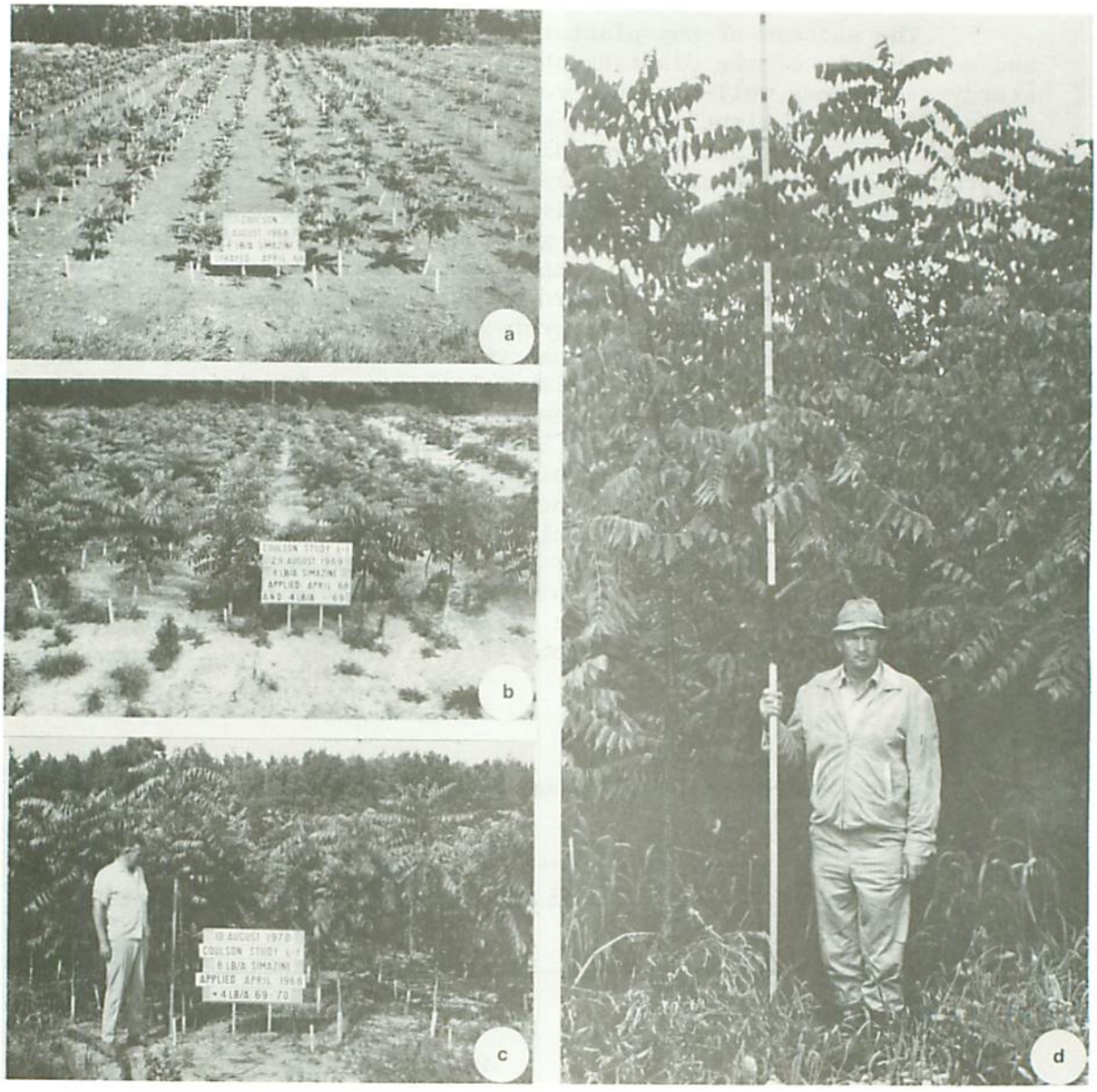

Figure 1. Walnut plantation development a) first year, b) second year, c) third year, d) fourth year

PLANTING METHOD

Although most hardwood seedlings are currently planted with a spade by the wedge or slit method, planting machines suitable for hardwood planting have recently been developed. To improve the efficiency of large-tree planting, I tested the suitability of portable, motorized post-hole diggers with soil bits of 6 and 10 inches in diameter. I found that the preparation of planting holes with the post-hole digger is the most economical method of planting large trees. However, little growth advantage was gained by seedlings planted in holes prepared by the auger as against those planted by the wedge method. Currently the most economical method of plantation establishment is the planting of seedlings by wedge method or with a planting machine.

DIRECT SEEDING

Hardwood establishment by direct seeding has been investigated as an alternate method to planting of nursery-grown stock. Advantages of direct seeding are the reduction in planting costs and the 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). However, in areas where squirrels were common, successful seeding of black walnut was impossible without protecting the seed spots by screens or hardware cloth (von Althen 1969b). Until more successful seeding methods are developed, planting of nursery-grown seedlings guarantees better plantation establishment than direct seeding.

FERTILIZATION

Since low fertility is one of the characteristics of land withdrawn from agriculture, fertilization may be necessary for successful hardwood afforestation on nutrient deficient sites. However, fertilization will never compensate for unfavorable site conditions, such as shallow topsoil, imperfect drainage, excessive exposure or other conditions detrimental to quality hardwood growth. Although it is well known that hardwood growth depends to a large degree on the level of nutrient availability in the soil, exact values of nutrient requirements of individual hardwood species have not yet been determined. In my experiment near Richmond Hill, fertilization improved 8-year height growth of white ash, silver maple and black-locust by 100, 33 and 20 percent, respectively (von Althen unpublished manuscript). In other experiments fertilization at time of establishment failed to improve 3-year height growth of planted black walnut [*Juglans nigra* L.],

silver maple, red oak [*Quercus rubra* L.] and basswood [*Tilia americana* L.]. This indicates that nutrient availability was not a limiting factor on these sites. While fertilization with a balanced fertilizer may be expected to benefit planted hardwood seedlings on all sites, a significant return on an investment in fertilization will only be obtained on sites with known mineral deficiencies. In other words, fertilization is a prerequisite to quality hardwood growth on marginal planting sites. On good sites fertilization will do little to improve hardwood growth and the money available for afforestation may be spent more profitably on intensive site preparation and weed control.

The success of any fertilization will depend on the effectiveness of weed control. Where weed control is ineffective, fertilization may do more harm than good because the newly planted tree seedlings will soon be suppressed by the fertilized weeds.

RODENT CONTROL

Tree girdling by mice and browsing by rabbits can cause heavy damage in hardwood plantations (von Althen 1971a). Poisoning the mice and applying rabbit repellents, such as Arasan 42 S or Thiram, can provide some protection but these methods are rather expensive for the degree of protection they afford. By far the best protection against rodent damage is the elimination of weeds; this deprives the the animals of shelter and food and makes the plantation a hostile environment for rodent survival and reproduction. Also, weed control generally increases tree growth, and fast-growing trees are less vulnerable to rodent damage because they soon outgrow the danger.

COST OF PLANTATION ESTABLISHMENT

The establishment costs per acre of hardwood plantation will vary widely, depending on such factors as plantation size and shape, topography, accessibility, soil texture, soil fertility, former land use, density and composition of existing cover, as well as many other factors. The following example applies to average conditions on former agricultural land and should, therefore, be regarded as a general guide only (Table 3).

Table 3. Approximate per acre cost of hardwood plantation establishment

Plowing in July of the year before spring planting	$ 15.00
Disking shortly after plowing	7.50
Second disking in August or September of the same year	7.50
Planting stock, 1,000 seedlings	10.00
Machine planting	30.00
Application of fertilizer	5.00
Six pounds of active Princep at $3.15/lb	18.90
Broadcast application of Princep shortly after planting	3.00
Three pounds of active Princep at $3.15/lb	9.45
Broadcast application of Princep in April of the second year	3.00
Total	$109.35

SUMMARY

The requirements for successful hardwood plantation establishment are:

1. A deep, moist but well-drained planting soil;
2. Plowing and disking of the total area;
3. Healthy, sturdy planting stock;
4. Careful planting;
5. Effective weed control for the first 2 years;
6. Fertilization where necessary;
7. Rodent control where necessary.

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