PLANTING TRIALS WITH BLACK WALNUT AND WHITE ASH TRANSPLANTS IN SOUTHERN ONTARIO

F. W. VON ALTHEN

GREAT LAKES FOREST RESEARCH CENTRE

SAULT STE. MARIE, ONTARIO

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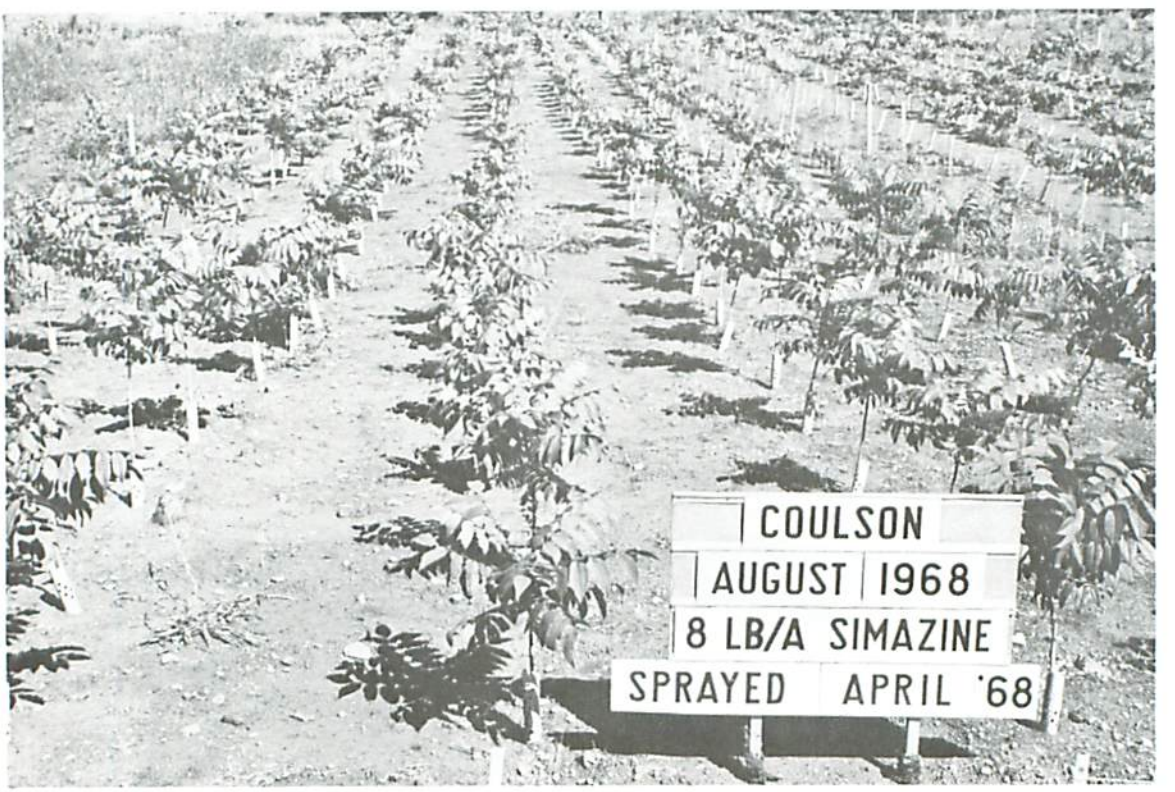
Director,
Great Lakes Forest Research Centre,
Canadian Forestry Service,
Department of the Environment,
Box 490, Sault Ste. Marie, Ontario.
P6A 5M7

ABSTRACT

A series of experiments was carried out near Hornby, Ontario to determine the effects of planting-stock age, planting method, fertilization, site preparation and weed control on the 3-year survival and height growth of black walnut (*Juglans nigra* L.) and white ash (*Fraxinus americana* L.) seedlings and transplants. Weed control *after* planting proved to be the single most important treatment improving the height growth of both species. Age of planting stock and planting method had little effect on the survival and height growth of black walnut and white ash seedlings and transplants but survival and height growth of pregerminated walnut seeds planted in peat pots were significantly lower than those of seedlings and transplants. Plowing and disking significantly improved black walnut survival in plots without subsequent weed control. Fertilization improved the height growth of white ash. Recommendations are made for the successful establishment of black walnut and white ash plantations in southern Ontario.



Frontispiece. First-year height growth of well-established black walnut plantation.

TABLE OF CONTENTS

Cover photo shows a 6-year-old white ash plantation consisting of mixed rows of seedlings and transplants, Hornby, Ontario. (Measuring stick is 6 ft long.)

INTRODUCTION

Tree planters have often expressed a preference for large hardwood planting stock, on the assumption that transplants 2-5 years old and 2-6 ft[1] tall would eliminate the need for intensive site preparation and weed control. Although large hardwood planting stock has been used successfully in reforestation in Germany (Nather 1968, Reissinger 1971) and is used extensively in landscape gardening and in plantings along highways, little information is available on its suitability for afforestation of weed-infested soils. To evaluate the potential of large planting stock for hardwood afforestation in southern Ontario, experiments were carried out comparing the survival and height growth of black walnut (*Juglans nigra* L.) and white ash (*Fraxinus americana* L.) seedlings and transplants with respect to site preparation, planting method, weed control, and fertilization. The 3-year results of these experiments are reported here.

EXPERIMENTAL AREA

All experiments were carried out in a field near Hornby, Halton County, Ontario. The soil was an imperfectly drained clay loam 18-24 in. deep over compact clay changing to compact sand at a depth of 45 in. The pH of the plow layer was 6.8. Ground cover consisted of a vigorous stand of quack grass (*Agropyron repens* [L.] Beauv.), goldenrod (*Solidago* spp.), milkweed (*Asclepias* spp.), Canada thistle (*Cirsium arvense* L.) and wild carrot (*Daucus carota* L.).

AGE OF PLANTING STOCK, PLANTING METHOD AND FERTILIZATION

The experimental area was plowed and disked in the autumn before each year's spring planting. Princep® was broadcast over the total experimental area shortly after planting and in April of the next two years at 8, 4 and 4 lb/acre of active ingredient for black walnut and 4, 2 and 2 lb/acre for white ash. Details of the experiments are given below under Studies 1-3. The essential difference between Studies 1 and 2 was an increase in the number of planting methods used and the addition of a fertilizer treatment in the second study. The efficiency of planting methods was measured in Study 3.

Study 1

Black walnut and white ash seedlings (Table 1) were planted in April, 1968 either by the wedge method or in auger holes 10 in. in diameter and 12 in. deep. Plots of 16 black walnut and white ash transplants were planted either in holes 7 x 7 x 9 in. or in auger holes 10 in. in diameter. In June of the same year plots of 16 pregerminated black walnut

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[1] The basic conversion factors for all measurements given in this report are found in the Appendix.

Table 1 Size of planting stock

Year of planting	Species	Age class	Length of stem (in.)	Stem diam at 1 in. above root collar (in.)	Top-to-root ratio (o.d.w.)
1968	black walnut	Pregerminated nuts in 4 in. x 7 in. peat pots			
	black walnut	1+0	11	.25	-
	black walnut	1+1	20	.34	-
	black walnut	1+3	33	.45	-
	white ash	2+0	12	.27	-
	white ash	2+2	30	.38	-
	white ash	2+3	38	.59	-
1969	black walnut	Pregerminated nuts in 4 in. x 7 in. peat pots			
	black walnut	1+0	11	.26	1:2.2
	black walnut	1+1	14	.34	1:3.8
	black walnut	1+2	28	.38	1:1.7
	white ash	2+0	13	.30	1:2.0
	white ash	2+2	33	.43	1:1.1
1970	black walnut	1+0	13	.24	1:2.4
	black walnut	1+1	15	.39	1:3.6
	black walnut	1+2	31	.45	1:1.5
	black walnut	2+2	42	.70	1:1.4
	white ash	2+0	12	.30	1:1.9
	white ash	2+2	41	.51	1:0.8

seeds in peat pots were planted either in holes 7 x 7 x 9 in. or in auger holes 10 in. in diameter. All trees were planted at 4 x 4 ft spacing.

The experiment was laid out in the following factorial arrangement:

Walnut: Stock age (4) x planting method (2) x replications (6) = 48 treatment combinations x 16 trees = a total of 768 trees.

Ash: Stock age (3) x planting method (2) x replications (6) = 36 treatment combinations x 16 trees = a total of 576 trees.

Study 2

Black walnut and white ash seedlings (Table 1) were planted in April, 1969 either by the wedge method or in auger holes 6 or 10 in. in diameter and 12 in. deep. Plots of 16 black walnut and white ash transplants were planted either in holes 7 x 7 x 9 in. or in auger holes 6 or 10 in. in diameter. In June of the same year plots of 15 pregerminated black walnut seeds in peat pots were planted either in holes 7 x 7 x 9 in. or in auger holes 6 or 10 in. in diameter. All trees were planted at 4 x 4 ft spacing. One-half of the plots were fertilized by placing one tablet containing 9 g of 22-8-2 fertilizer in the bottom of each planting hole.

The experiment was laid out in the following factorial arrangement:

Walnut: Stock age (4) x planting method (3) x fertilization (2) x replications (4) = 96 treatment combinations x 15 trees = a total of 1440 trees.

Ash: Stock age (2) x planting method (3) x fertilization (2) x replications (4) = 48 treatment combinations x 15 trees = a total of 720 trees.

Seedling and transplant survival and height growth of both studies were recorded after the first and third growing seasons with the third-year data subjected to analyses of variance and Duncan's new multiple-range test (Steel and Torrie 1960).

Study 3

Time studies were carried out during the planting phase of Studies 1 and 2 to determine the relative efficiency of the planting methods used for seedlings and transplants. During wedge planting, one man cut and lifted the wedge with a spade while a second man

planted the trees. Planting holes 7 x 7 x 9 in. were dug by two men who also planted the trees after completing 16 holes. Auger holes were made by a two-man crew and a third man planted the trees (Figure 1). No allowance was made for travel time, rest periods, machine maintenance, etc.

Results of Studies 1, 2 and 3

Age of planting stock had little effect on the survival of black walnut and white ash seedlings and transplants (Tables 2 and 3). In contrast, the survival of pregerminated walnut seeds planted in peat pots was significantly lower than that of seedlings and transplants.

Age of planting stock also had little effect on the height growth of walnut seedlings and transplants but 3-year height growth of pregerminated walnut seeds planted in peat pots was significantly lower than that of the seedlings and transplants in all treatments in Study 1 and in two out of six treatments in Study 2. Height growth of white ash transplants was significantly better than that of the seedlings in five out of six treatments in Study 2.

Planting method had little effect on the survival and height growth of black walnut and white ash seedlings and transplants. However, the survival and height growth of the spade-planted, fertilized, pregerminated walnut seeds of Study 2 were significantly lower than those of all other treatments of the same study.

Fertilization improved the height growth of white ash, but did not affect white ash or black walnut survival or black walnut height growth (Table 3).

The time study of different planting methods revealed that wedge planting was the most efficient method, followed by the 6-in.-diameter auger, the 10-in.-diameter auger and finally the 7 x 7 x 9 in. planting holes made with a spade (Table 4).

AGE OF PLANTING STOCK, SITE PREPARATION AND WEED CONTROL

The previous studies revealed that, with the exception of the pregerminated walnut seeds, age of planting stock and planting method had little effect on the survival and height growth of black walnut and white ash seedlings and transplants planted in plowed, disked and chemically weeded soil. It was therefore decided to carry out a further experiment to measure the effects of site preparation and weed control.

Study 4

In the autumn of 1969, one-half of the experimental area was plowed and disked. In April of 1970, 2 qt/acre of gramoxone were

Figure 1. Portable soil auger with 10-in. bit.

Table 2 Study 1. Effects of age of planting stock and planting method on 3-year survival and height growth of black walnut and white ash. All plots plowed, disked and treated with Princep (Each value represents the mean of 96 trees.)

Species	Age class	Survival (%)		Height growth (in.)	
		Spade	10-in. auger	Spade	10-in. auger
Black walnut	seeds	60	57	39	40
	1+0	94	98	70	66
	1+1	98	100	64	66
	1+3	99	91	56	59
White ash	2+0	99	100	55	46
	2+2	100	100	58	56
	2+3	100	100	63	55

Table 3 Study 2. Effects of age of planting stock, planting method and fertilization on 3-year survival and height growth of black walnut and white ash. All plots plowed, disked and treated with Princep (Each value represents the mean of 60 trees.)

		Survival (%)						Height Growth (in.)					
		Fertilized			Not Fertilized			Fertilized			Not Fertilized		
Species	Age class	Spade	6-in. auger	10-in. auger	Spade	6-in. auger	10-in. auger	Spade	6-in. auger	10-in. auger	Spade	6-in. auger	10-in. auger
Black walnut	seeds	18	47	33	43	40	30	26	43	43	47	47	38
	1+0	98	92	90	93	95	98	56	57	58	58	56	64
	1+1	100	93	100	100	95	100	76	73	76	64	70	81
	1+2	98	90	100	100	95	98	58	54	58	61	48	55
White ash	2+0	95	98	98	88	98	100	50	65	66	43	69	55
	2+2	100	100	100	100	100	100	80	85	83	74	77	74

Table 4 Effect of planting method on the time required to plant black walnut and white ash seedlings and transplants

Planting method	Time required to [a]		
	Make hole (man/sec)	Plant tree (man/sec)	Total (man/sec)
Wedge planting	-	-	39
Planting hole 7 x 7 x 9 in. made with a spade	43	57	100
Planting hole made with a soil auger 6 in. in diam and 12 in. deep	23	34	57
Planting hole made with a soil auger 10 in. in diam and 12 in. deep	29	34	63

[a] No allowance was made for travel time, rest periods, machine maintenance, etc.

broadcast over the unplowed half of the area. One week later 16 black walnut and white ash seedlings or transplants (Table 1) were planted in auger holes 10 in. in diameter and 12 in. deep. Spacing was 6 x 6 ft for all trees. Shortly after planting and in April of the next 2 years Princep was broadcast over one-half of the plowed and one-half of the gramoxone-treated areas in the following dosages (lb/acre of active ingredient): black walnut 8, 4, 4; white ash 4, 4, 2.

The experiment was laid out in the following arrangement:

Walnut: Site preparation (2) x stock age (4) x weed control (2) x replications (4) = 64 x 16 trees = a total of 1024 trees.

Ash: Site preparation (2) x stock age (2) x weed control (2) x replications (4) = 32 x 16 trees = a total of 516 trees.

Seedling and transplant survival and height growth were recorded after the first and third growing seasons with the third-year data subjected to analyses of variance and Duncan's new multiple-range test (Steel and Torrie 1960).

Results of Study 4

Weed control after planting was the single most important treatment improving the height growth of both species (Table 5). Height growth of all age classes of planting stock of both species was significantly better in the Princep-treated plots than in those without weed control (Figures 2 and 3).

Plowing and disking significantly improved black walnut survival in plots without subsequent weed control. It also improved the height growth of both species in plots with weed control and, to a lesser extent, in plots without weed control.

Age of planting stock had little effect on the survival or height growth of either species.

DISCUSSION

Survival of pregerminated walnut seeds placed in peat pots was poor for several reasons. In the 1968 planting (Study 1) survival was nearly 100 percent during the first summer. However, up to 35 percent of the seedlings died during the first winter, probably as the result of insufficient hardening-off. In the 1969 planting (Study 2) 40-50 percent of the peat pots were washed out of the ground 3 weeks after planting when a violent thunderstorm caused a small creek to overflow

Table 5 Study 4. Effects of site preparation, weed control and age class of planting stock on 3-year survival and height growth of black walnut and white ash (Each value represents the mean of 64 trees.)

Species	Age class	Survival (%)				Height growth (in.)			
		Plowed and disked		Gramoxone		Plowed and disked		Gramoxone	
		Princep	No Princep	Princep	No Princep	Princep	No Princep	Princep	No Princep
Black walnut	1+0	94	91	100	46	44	4	42	2
	1+1	96	17	92	39	54	13	40	4
	1+2	94	83	94	43	46	2	32	2
	2+2	97	88	97	20	34	5	23	0
White ash	2+0	83	85	99	83	37	19	36	13
	2+2	97	94	99	88	47	18	36	18

Figure 2. Four-year-old black walnut after application of 8, 4, and 4 lb/acre of Princep.

Figure 3. Four-year-old black walnut without Princep application.

its banks. Since height growth of the surviving container-planted seedlings was also inferior to that of the nursery-grown stock, planting of pregerminated nuts placed in peat pots was the least satisfactory method of walnut establishment.

Age of planting stock had only a minor effect on the survival and height growth of black walnut seedlings and transplants. With few exceptions survival and height growth of black walnut seedlings and transplants were equally good in the plowed, disked and chemically weeded plots and equally poor in plots without weed control. Height growth of white ash transplants was better than seedling growth in half of the plowed, disked and chemically weeded plots, but was equally poor in all plots without weed control. Since transplants are from three to six times more expensive to produce, ship, and plant than seedlings (von Althen 1971), but offer no saving in site preparation or weed control, it is obvious that seedlings are the more economical form of planting stock.

Wedge planting was the most efficient method of planting seedlings, but because of their large roots, transplants could not be planted in this manner. Drilling holes with a portable power auger 6 in. in diameter was fast and efficient. However, the planting of large transplants with spreading roots required extensive root pruning to reduce the diameter of the root mass to 6 in. Packing the soil around the roots also presented problems owing to the depth of the hole in relation to its diameter. To compensate for the inevitable settling of the soil we placed an extra shovelful of soil over the hole to form a small mound around the stem. But even then depressions developed in subsequent weeks around a number of stems, indicating the presence of large air pockets in the root zone at time of planting.

Drilling holes with a portable power auger 10 in. in diameter was fast and efficient in cultivated stone- and weed-free soils. However, in soils containing rocks or roots or in soils covered with grass the auger performed poorly; it jammed, was difficult to hold, and required frequent stops to clean the bit. Planting in the 10-in.-diameter holes was easy because the soil removed by the auger was always crumbly even in moist, plastic soils. Firming the soil around the tree roots was also relatively easy because the large diameter of the hole allowed packing with the heel of the boot.

Digging holes 7 x 7 x 9 in. with a spade in the clay loam was very exhausting and close supervision was required to assure the correct depth of the planting holes. Planting in holes dug by hand required two men, one to hold the transplant vertical, the other to fill the hole. Large chunks of soil, removed from the hole, had to be broken up before replacement to prevent the formation of air pockets around the tree roots.

Plowing and disking of the total plantation area destroyed all weeds, added organic material to the soil and was a prerequisite to acceptable walnut survival in plots without subsequent weed control. The superiority of plowing and disking over site preparation by chemical mowing with gramoxone was further demonstrated by the improved height growth of black walnut in nearly all of the plowed and disked plots.

Weed control after planting was the single most important treatment in the successful establishment of black walnut and white ash seedlings and transplants. In the studies reported here we applied Princep with a backpack sprayer shortly after planting and in the spring of the second and third growing seasons. In subsequent operational planting trials Princep was applied with a boom sprayer mounted on a farm tractor. This worked well as long as the seedlings were small enough to pass under the booms. Because walnut seedlings commonly grow slowly during the first year after planting (Williams 1965), Princep could be applied with a boom sprayer shortly after planting and in the spring of the second growing season. However, the boom sprayer could not be used when seedlings or transplants were more than 3 ft tall because many apical buds were damaged when scraped by the booms. White ash seedlings were frequently damaged in the spring of the second growing season because they were over 3 ft tall. In walnut plantations we generally applied 8, 4, and 4 lb/acre, respectively, of active Princep in the first 3 years after planting. To mechanize Princep applications we experimented with applications of 6 lb/acre in the spring of the first 2 years after planting. This provided near-perfect weed control during the first 2 years and 50 percent control during the third year. White ash tolerates a maximum of only 4 lb[2] of active Princep which can be applied with a boom sprayer shortly after planting. But 4 lb/acre of active Princep controls weed growth on fertile sites for only 1 year while successful white ash establishment requires effective weed control for 3 years. Therefore, second- and third-year application will still require manual spraying.

SUMMARY AND RECOMMENDATIONS

Studies 1 and 2 show that age of planting stock, planting method and fertilization had little effect on the survival and height growth of black walnut seedlings and transplants growing in plowed, disked and chemically weeded plots. However, the survival and height growth of pregerminated walnut seeds planted in peat pots were always inferior to those of seedlings and transplants.

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[2] On loam or sandy loam white ash tolerates a maximum of only 3 lb/acre of active ingredient.

While the survival of white ash seedlings and transplants was 83 percent or better under all treatments of Studies 1 and 2, height growth of the white ash transplants was significantly better than seedling growth in five out of six treatments in Study 2.

Fertilization improved the height growth of white ash but not of black walnut.

Study 4 shows that weed control *after* planting was the prerequisite to successful black walnut and white ash establishment and early growth. Since height growth of black walnut and white ash seedlings and transplants was always significantly better in the plots with weed control than those without weed control it is quite apparent that weed control was the most important factor and that the use of large planting stock is no substitute for weed control.

On the basis of the results of these and previous studies, the following recommendations are made for black walnut and white ash afforestation in southern Ontario:

1. Plowing and disking of the total planting site or, where this is not feasible, plowing of strips at least 8 ft wide.

2. Wedge or machine planting of 1+0 black walnut and 2+0 white ash seedlings.

3. Broadcast application of Princep over the total plantation area or application in strips at least 8 ft wide shortly after planting and in the spring of the next 2 years at the following dosages (lb/acre of active ingredient): black walnut 6, 6 and 4; white ash 3, 3 and 3.

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APPENDIX

APPENDIX

The basic conversion factors for all measurements given in this report are as follows:

1 inch = 2.54 centimeters

1 foot = 30.48 centimeters

1 pound per acre = 1.12 kilograms per hectare

1 gram = 0.03 ounces

1 quart per acre = 2.80 liters per hectare