BLACK WALNUT SEEDING VERSUS PLANTING IN A PLANTATION WITH PRINCEP® WEED CONTROL

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

Germination, survival and 3-year growth of seeded black walnut (*Juglans nigra* L.) were compared with the survival and growth of nursery-grown 1+0 seedlings planted in a former agricultural field near Parkhill, Ontario. All plots were treated with 4.48 kg/ha (4 lb/acre) of Princep® in the spring of the first two years after seeding or planting. Direct seeding treatments included autumn sowing of newly collected nuts and spring and autumn sowing of nuts stratified for 8 to 20 months. Nursery-grown seedlings were planted in autumn and spring. Survival of spring-planted, nursery-grown seedlings was significantly better than that of all other treatments. No single treatment significantly improved height growth. The most successful direct seeding treatment was autumn sowing shortly after collection of hulled and graded nuts. Spring planting of 1+0 nursery-grown seedlings is recommended as the best regeneration method for walnut plantation establishment in southern Ontario.

RÉSUMÉ

L'auteur a comparé la germination, la survie et la croissance, sur une période de trois ans, de noyers noirs (*Juglans nigra* L.) ensemencés, avec la survie et la croissance de plants 1+0, semés en pépinière et plantés dans un champ servant antérieurement pour fins agricoles tout près de Parkhill, Ontario. Lors de chaque printemps des deux premières années après l'ensemencement ou la plantation, il traita tous les placeaux à raison de 4.48 kg/ha (4 lb/acre) de Princep®. Les traitements de l'ensemencement direct consistaient en l'ensemencement à l'automne de noix récemment cueillies, et l'ensemencement au printemps et à l'automne de noix stratifiées pendant 8 à 20 mois. La plantation fut faite à l'automne et au printemps. La plantation printannière fut la plus efficace. Aucun traitement individuel n'a amélioré significativement la croissance en hauteur des semis. Quant à l'ensemencement direct, le plus efficace fut celui à l'automne, presqu' immédiatement après la cueillette de noix écalées et classées. On recommande la plantation au printemps de plants 1+0 semés en pépinière, comme la meilleure méthode de régénération dans les plantations de noyers dans le sud de l'Ontario.

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INTRODUCTION

Black walnut (*Juglans nigra* L.) may be regenerated by either direct seeding or the planting of nursery-grown seedlings. The advantages of direct seeding are: 1) the saving of nursery costs, 2) generally lower planting costs, and 3) the prevention of root injury which is unavoidable in the planting of nursery-grown seedlings (Seidel 1961). The disadvantages of direct seeding are: 1) nut pilferage by rodents, 2) unreliability of germination, and 3) slow growth during the early years after seeding (von Althen 1969).

Black walnut seeds have a very pronounced dormancy which must be broken by extended low-temperature stratification before the seeds will germinate (Anon. 1965). The most common methods of stratification are: 1) natural stratification during the winter, effected by sowing the previous autumn, and 2) stratification in an outdoor soil pit or in moist sand in a cold room. However, despite stratification, germination is often delayed so that sown nuts may germinate over a period of several months or even as late as the summer of the second year. Such delay in germination is highly undesirable because seedlings emerging after the end of June generally remain small and often fail to harden off sufficiently to escape injury from early autumn frost. Furthermore, a delay in germination until the second year will necessitate an additional year of weed control which greatly increases establishment costs.

To develop methods to advance the time of germination and to improve total germination a preliminary experiment was carried out in 1969. Walnut seeds were stratified in a cold room at 0°C (32°F) for 7, 19 and 31 months. Between 69 and 81% of all nuts stratified for 19 months germinated within 3 weeks of sowing but only 10-25% of the nuts stratified for 7 months had germinated after 12 weeks (von Althen 1971a). When the nuts which had not germinated after 12 weeks in the seedbed were given an additional 9 months' stratification, 81% germinated within 3 weeks. Many of the nuts stratified for 31 months had germinated prematurely in storage. Although the nuts in this experiment were germinated in a greenhouse under ideal conditions, the results obtained were encouraging and a second experiment was initiated in the autumn of 1971.

This study was designed to compare the germination, survival and early growth of sown walnuts with the survival and growth of planted, nursery-grown 1+0 seedlings. The 3-year results of this study are described in this report.

EXPERIMENTAL AREA

The study was carried out in a former agricultural field near Parkhill, Ontario. The soil was slightly eroded, imperfectly drained loam (Parkhill loam) over clay loam at a depth of 35.6 cm (14 in.). The pH of the plow layer was 7.2 and the organic matter content was 3.2%.

METHOD

The experimental field was plowed in the spring and disked repeatedly during the summer prior to autumn or spring seeding and planting. Black walnut seeds were collected for 3 consecutive years from the same grove of superior trees near Aurora, Ontario. While the nuts in one treatment were sown with the hulls left on, the nuts in all other treatments were first hulled and graded by water flotation. Hulling was effected by tumbling the nuts in a cement mixer containing water and several rough-edged rocks which helped remove the hulls. Grading consisted of placing the hulled nuts in a tub of water and discarding those that floated because they either were hollow or contained only partially developed kernels. The nuts were then either stratified outside in a 45.7-cm (18-in.)-deep soil pit or stored in metal garbage containers between 7.6 cm (3 in.) of moist sand in cold rooms at 0°C (32°F) or 5.5°C (42°F).

The 1+0 seedlings were obtained from the Ontario Ministry of Natural Resources nursery at St. Williams. Average height of the seedlings was 40.6 cm (16 in.) and average diameter was 1.8 cm (0.35 in.) measured 2.54 cm (1 in.) above the root collar.

The experiment was laid out in a random block design with five replications of each of 11 treatments. Each replication consisted of either 20 seed spots or 20 seedlings. One nut was planted in each seed spot and covered with approximately 5 cm (2 in.) of soil. The 1+0 seedlings were planted by spade using the wedge method. Spacing of seedlings and seed spots was 251.84 cm (8 ft) between rows and 182.88 cm (6 ft) within rows. Shortly after spring planting and in April of the second year 4.48 kg/ha (4 lb/acre) of active Princep® were broadcast over the total area. This chemical weed control was augmented during the first two summers by occasional hoeing around individual seedlings that required relief from competing vegetation.

Eleven treatments were tested, as outlined in Table 1. Germination, survival and growth were recorded for 3 years and the data were subjected to analysis of variance and Duncan's multiple range test (Steel and Torrie 1960).

RESULTS

Survival of the spring-planted, nursery-grown seedlings (Treatment 11) was significantly better than that of all other treatments (Table 1). Total germination within sowing treatments ranged from 7 to 64% with no significant differences among the six best treatments. No single treatment significantly increased 3-year height growth of either sown or planted seedlings, but height growth of sown seedlings

Table 1. Germination, survival and height of sown and planted black walnut

Treatment	Germination			3-yr survival	3-yr ht growth	
	1st yr (%)	2nd yr (%)	Total (%)	(%)	(cm)	(in.)
1. Nuts with hulls sown shortly after collection in October, 1971	24	5	29 b	24 g	66	26 yz
2. Hulled and graded nuts sown shortly after collection in October, 1971	50	0	50 a	36 efg	81	32 xy
3. Hulled and graded nuts stored for 12 months at 5.5°C (42°F) sown in October, 1971	47	0	47 a	30 fg	84	33 xy
4. Hulled and graded nuts stored for 12 months at 0°C (32°F) sown in October, 1971	7	0	7 c	6 h	104	41 x
5. Nursery-grown seedlings (1+0) planted in October, 1971	-	-	-	57 efg	74	29 yz[a]
6. Hulled and graded nuts stratified for 8 months in an outside soil pit sown in May, 1972	42	14	56 a	31 efg	69	27 yz
7. Hulled and graded nuts stored for 8 months at 5.5°C (42°F) sown in May, 1972	26	38	64 a	32 fg	48	19 z
8. Hulled and graded nuts stored for 8 months at 0°C (32°F) sown in May, 1972	29	26	55 a	32 fg	58	23 yz
9. Hulled and graded nuts stored for 20 months at 5.5°C (42°F) sown in May, 1972	14	45	59 a	43 efg	48	19 z
10. Hulled and graded nuts stored for 20 months at 0°C (32°F) sown in May, 1972	1	9	10 c	9 h	51	20 z
11. Nursery-grown seedlings (1+0) planted in May, 1972	-	-	-	97 d	84	33 xy[a]

[a] Figures do not include height of seedling at time of planting.

Note: Common letters denote treatments which showed no significant difference (5%) in germination, survival or height.

was closely correlated with time of seedling emergence (Table 2). While total germination of the spring- and autumn-sown nuts was 49% and 33%, respectively, germination of the autumn-sown nuts was 94% completed by August of the first year compared with only 54% completion for the spring-sown nuts.

Table 2. Effect of date of emergence on survival and height growth of sown black walnut

Date of emergence	Germination (%)	Survival in autumn 1974 (%)	Average ht in autumn 1974 (cm)	(in.)
8/6/72	5.1	83	97	38
22/6/72	6.4	52	89	35
6/7/72	6.3	54	74	29
20/7/72	5.4	73	74	29
3/8/72	2.3	62	48	19
17/8/72	1.0	33	43	17
5/6/73	11.8	73	41	16
19/6/73	3.2	59	41	16
2/7/73	-	-	-	-
16/7/73	0.1	100	20	8
30/7/73	0.1	100	18	7

DISCUSSION

The high mortality of the autumn-planted, nursery-grown seedlings (Treatment 5) was caused by severe frost heaving during the first winter when the heavy-textured and imperfectly drained soil was exposed to repeated freezing and thawing. Although frost heaving damage is generally lower on lighter-textured and better-drained soils, the risk of frost heaving will seldom outweigh the advantages of autumn planting.

In other words, why plant in autumn and take the chance of suffering frost-heaving damage when spring-planted seedlings will grow as well as or better than autumn-planted seedlings?

Total germination and survival of germinants were probably unfavourably influenced by the application of Princep®. However, we used Princep® intentionally because young black walnut seedlings are very susceptible to weed competition (Byrnes 1966) and the application of Princep® is at present the most economical method of weed control. Manual or mechanical cultivation could probably have increased germination and seedling survival but these treatments are very expensive and therefore have only limited application in plantation establishment. Contact herbicides such as Gramoxone, Amino Triazole or Roundup® can control weed competition very effectively, but these herbicides must be applied as directed sprays, a difficult and time-consuming operation when tree seedlings are small. In addition, application of these herbicides may be ecologically unacceptable to some landowners.

When a review of literature revealed that no optimum temperature for walnut stratification had yet been determined (Barton 1936, Chase 1947) we selected 0°C (32°F) as a follow-up to our 1969 study (von Althen 1971a) and 5.5°C (42°F) because cold room space at this temperature is generally readily available in fruit storage facilities.

Comparison of total germination at the two temperatures reveals a significantly higher germination at 5.5°C (42°F) than at 0°C (32°F) in two out of three possible comparisons. However, total germination of seeds stratified at 5.5°C was no better than that of hulled nuts stratified over winter in an outdoor pit, or of nuts sown in autumn shortly after collection. Since these results compare closely with those of Chase (1947) and Williams (1971b) the most economical method of walnut stratification appears to be sowing in autumn shortly after nut collection or over-winter stratification in an outdoor soil pit and sowing in early spring.

The difference in total germination between the hulled and unhulled nuts (treatments 1 and 2) was probably due to the grading of the hulled nuts rather than the effect of the hulls on germination (Williams 1971a). When nuts are hulled the seeds can be graded by water flotation and the empty seeds discarded. But grading is not possible when the hulls are left on and the number of hollow seeds therefore remains unknown.

Sowing more than one nut per seed spot would undoubtedly increase stocking. However, at the same time more than one seedling will emerge on many spots, necessitating an expensive early thinning to assure satisfactory growth.

While total germination and survival of the spring-sown nuts were higher than those of autumn-sown nuts, the latter germinated sooner

and grew taller. The more rapid germination of the autumn-sown nuts was probably caused by the additional 8 months of stratification these seedlings received in the soil of the planting site during the first winter. The importance of early seedling emergence is well demonstrated in this study by the fact that seedlings which emerged in June or early July generally survived better and grew taller than those that emerged later (Table 2). The high mortality of seedlings that emerged on 22 June and 7 July, 1972 was caused by a severe drought during July of that year. The survival of the two seedlings that emerged on 16 and 30 July, 1973 appears to be an exception to the general trend.

SUMMARY AND RECOMMENDATIONS

1. Spring planting of 1+0 nursery-grown seedlings was the most successful regeneration method of those tested.

2. Autumn-planted 1+0 nursery-grown seedlings were subject to severe frost heaving in the heavy-textured, imperfectly drained planting soil.

3. If direct seeding is called for either because of a lack of planting stock or at the express request of the landowner, autumn sowing of hulled and graded nuts is recommended. If spring sowing is preferred, the hulled and graded nuts should be stratified over winter in an outside soil pit of at least 30.48 cm (1 ft) in depth.

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

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