ARTIFICIAL REGENERATION OF BLACK WALNUT

STUDIES OF SEEDING, PLANTING, AND CONTAINER-PLANTING

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THE PROBLEM

Natural regeneration of black walnut is currently inadequate in most woodlots of southern Ontario and artificial regeneration methods have often failed to achieve the desired success. Until a few decades ago walnut trees were common in many woodlots. But the extraordinarily high value of large-diameter logs resulted in such an enormous increase in the rate of cutting that the number of mature trees has been seriously depleted. But aside from the scarcity of seed trees, natural walnut regeneration has never been very plentiful, because squirrels consume large quantities of nuts each year and young seedlings are very intolerant to shade and competition.

Artificial regeneration, therefore, appears to be the only method of reintroducing walnut trees into those woodlots that are currently void of seed trees or of increasing the number of these valuable trees in other woodlots.

Walnuts may be regenerated either by direct seeding or by planting nursery-grown seedlings. Direct seeding is generally preferred since it is easier and cheaper and since it prevents root damage that is unavoidable in the planting of nursery-grown stock. However, in many woodlots squirrels can make successful seeding impossible without seed protection. This paper reports the results of a series of studies designed to test the effectiveness of various protection methods and to compare the survival and early height growth of seeded, planted, and container-planted walnuts.

THE INVESTIGATIONS

Depth of Seeding

Deep seeding has been suggested as a means of reducing nut pilferage by squirrels. The protection afforded by deep seeding and its effect on germination and early height growth were investigated in the following studies.

Method

To determine the effect of deep seeding on the germination and early height growth of black walnut, 200 nuts each were seeded in the autumn of 1963 and the spring of 1964 at depths of 2, 6, and 10 inches. The planting site was a former hayfield with a uniform neutral clay over compact clay till at a depth of 2 feet. The Ontario Soil Survey places the soil in the Cashel Series. Before seeding, strips 2 feet wide were rototilled to a depth of 4 inches. Twenty-five seeds were planted with a spade in each of eight randomly located plots. Clean cultivation was maintained in all strips by manual weeding and the grass between the strips was mowed frequently.

In a second study, the effect of deep seeding on nut pilferage by squirrels was investigated in a natural hardwood woodlot. In the spring of 1964, 200 nuts each were planted at depths of 2, 6, and 10 inches in two openings of a woodlot which was inhabited by numerous grey and black squirrels. The woodlot soil was a clay loam over clay at a depth of 20 inches. The Ontario Soil Survey places the soil in the Huron Series. Two nuts were placed in each hole, which was spaded, in the centre of a scalp 18 inches in diameter.

All nuts used in these two studies were part of the same seedlot. They had been collected in the autumn of 1963 and had been dehulled and graded by water floatation. All nuts not seeded in the autumn were stored over winter in cool, moist sand.

Results

Study 1

Cumulative per cent germination of nuts seeded in the open field is shown in Figure 1 by date of emergence and depth of seeding. These graphs indicate that deep seeding not only delayed but also reduced total germination. Autumn-seeded nuts generally emerged sooner and their total germination was higher than that of spring-seeded nuts. The delayed emergence also greatly affected seedling survival (Table 1). Nearly all germinants which emerged after the middle of July were noticeably weaker at the end of the growing season than earlier emerged seedlings. This resulted in reduced winter hardiness and extensive mortality during the first winter. Three-year height growth of all surviving seedlings was little affected by either time or depth of seeding.

Table 1 Three-year survival and height growth of germinated walnuts seeded in autumn and spring in an open field at depths of 2, 6, and 10 inches

Depth of seeding in	Three-year survival		Three-year height growth	
	Autumn seeded %	Spring seeded %	Autumn seeded cm	Spring seeded cm
2	93	90	42	40
6	85	82	44	36
10	72	70	40	38

Study 2

In the woodlot planting, deep seeding did not prevent nut pilferage (Table 2). Over 60 per cent of all seed spots were disturbed within the first 4 weeks after seeding and a further 20 per cent were disturbed during the remainder of the year and the spring of the second year. Total emergence was only 4, 6, and 5 per cent for all nuts seeded at depths of 2, 6, and 10 inches, respectively (Figure 1).

Table 2 Per cent emergence of black walnuts seeded at various depths in a natural hardwood woodlot

Depth of seeding in	Emerged seeds %	Nuts eaten by squirrels %	Nuts failed to germinate %
2	4	86	10
6	6	80	14
10	5	78	17

Chemical or Mechanical Protection of Seeded Nuts

Method

The effectiveness of chemical and mechanical protection methods against nut pilferage by squirrels as well as differences in germination, survival, and growth of seeded, planted, and container-planted walnuts were compared in a 2-year study in southern Ontario. The experimental site consisted of three openings, of approximately 1/3 acre each, located in the centre of a natural hardwood woodlot. The soil was a clay loam over clay till at a depth of 20 inches (Huron Series). In early spring either two nuts were seeded 2 inches deep or one seedling was planted in the centre of a scalp 18 inches in diameter. Treatments were located randomly within openings that served as replications. All nuts were part of the same seedlot. They were collected in the autumn previous to spring seeding and were dehulled and stored over winter in cold, moist sand. The nuts used in the container-planting treatment were germinated in a greenhouse and seeded in a horticultural potting soil in peat pots 4 inches in diameter and 7 inches high. At the time of outplanting the germinants were 2 to 4 inches high.

Treatments consisted of:

1. Control, seeding without protection.

2. Seed spots protected by wire screens 24 inches high and 2.5 feet in circumference.

3. Seeds coated with Arasan 42S.

4. Arasan 42S sprayed over the soil surface of the seed spot.

5. Seeds planted in 10-ounce tin cans with the lower lid removed and two slits cut at right angles across the upper lid and the corners raised to an upright position.

6. One pregerminated nut planted in a peat pot and the seed spot protected by a wire screen 24 inches high and 2.5 feet in circumference.

7. Planting of one nursery-grown 1 + 0 seedling without protection.

Results

The protection of seed spots with wire screens and the planting of nursery-grown seedlings resulted in 5 and 6 times as many stocked spots, respectively, as the control (Table 3).

Height growth during the first two growing seasons was very limited for all seeding treatments. Planting shock, which is common in walnut but which is usually overcome within the first 2 years after planting, probably caused the slow growth of the planted seedlings.

To determine if squirrels were influenced in their search for nuts by changes in soil surface conditions due to seeding, several randomly located seed spots were prepared as usual, but no nuts were seeded in these spots. The squirrels completely ignored all seed spots without nuts, but dug up adjacent spots with nuts. This clearly indicates that they were not influenced by soil surface condition.

Table 3 Percentage of seed spots stocked and average growth of seedlings by treatments after two growing seasons

Treatment	Seed spots stocked %	Two-year height growth cm
Control, no protection	16	22
Seed spots protected by wire screens	80	27
Nuts coated with Arasan 42S	25	26
Arasan sprayed on the soil surface	21	25
Nuts planted in tin cans	56	24
One pregerminated nut planted in a peat pot and protected by wire screen	68	28
Nursery-grown 1 + 0 seedlings without protection	94	16

Seeding, Planting, and Container-planting

Method

To compare the germination, survival, and early height growth of directly seeded black walnuts, nursery-grown 1 + 0 seedlings, and pregerminated nuts planted in peat pots, a study was initiated in 1964. The experimental site was a fully cultivated field near Richmond Hill, Ontario with a uniform neutral clay over compact clay till at a depth of 2 feet (Cashel Series). A total of 150 seeds, 75 seedlings and 75 pregerminated nuts in peat pots were planted in five plots of 15 seed spots each. The seeded and pregerminated nuts were part of the same seedlot, whereas the 1 + 0 seedlings had been grown from seeds collected from the same trees in the previous year. In the container-planting, the pregerminated nuts were seeded in peat pots 4 inches in diameter and 4 inches high, using horticultural potting soil without fertilizer. At the time of outplanting, the seedlings were 3 to 4 inches high and growing actively.

Shortly after planting, ammonium nitrate, triple superphosphate, and potassium sulphate were broadcast on the soil surface at a rate of 100 pounds of nitrogen, 80 pounds of phosphorus, and 80 pounds of potassium per acre. Weeds were controlled by manual hoeing in June and July of the first 2 years after planting. All seed spots were protected from rodents by wire screens for the first 2 years after seeding and the planted seedlings were sprayed in the first two autumns after planting with the rabbit repellent Arasan 42S.

Results

After four growing seasons, survival of the planted 1 + 0 seedlings and the container-planted seeds was 97 per cent, but only 59 per cent of the seed spots were stocked (Table 4). Low germination was the main cause of this poor stocking. During the first summer only 49 of the possible 150 seeds produced seedlings on 42 seed spots. In the second summer, an additional five seeds germinated but two of the 49 original seedlings died and one of the new germinants did not survive. No mortality occurred after the second season but the weaker of two seedlings growing on the same seed spot was removed intentionally.

Table 4 Stocking and height growth of seeded, planted, and container-planted walnuts after four growing seasons

Planting method	Seed spots planted no.	Seed spots stocked %	Height growth cm
Two nuts planted 2 inches deep	75	59	108
1 + 0 seedlings	75	97	135
One pregerminated nut seeded in a peat pot and outplanted in the container	75	97	129

Total height growth after four growing seasons was best for the 1 + 0 seedlings despite their slow growth during the year of planting. Height growth of container-planted and directly seeded nuts did not differ statistically. Growth of the container-planted seeds was nearly equal to that of the planted seedlings. Fertilization greatly improved the growth of all trees.

The seeding of pregerminated nuts in peat pots and the subsequent outplanting of the actively growing seedlings in the containers is a promising new regeneration method. Its advantages are (1) assured germination, (2) freedom from root damage, (3) saving of time and nursery costs, and (4) possibly better establishment through early seedling growth in a favourable soil medium. The disadvantages are the necessity of seed spot protection in squirrel-infested woodlots and the currently high costs of production. The promising results obtained to date certainly warrant further development of this planting method with special emphasis on the type and size of container, type and fertility of the potting soil, as well as time and method of outplanting.

The planting of nursery-grown seedlings is usually the most efficient method of walnut establishment. The danger of root infection through wounds caused by root pruning cannot be discounted, but increased root rot in planted trees has not been proven and many excellent plantations have been established by planting nursery-grown seedlings. The size of the planting stock has an important bearing on seedling survival and early height growth and our experiences have shown that satisfactory growth can be obtained from seedlings 8 inches high having a root collar diameter of 0.25 inches. Since walnut is a demanding species, fertilization and weed control will increase survival and early growth.

RECOMMENDATIONS

These investigations collectively showed that the planting of nursery-grown seedlings was more successful than direct seeding. In woodlots where squirrels were common, deep seeding provided little protection, and it proved impossible to seed successfully without expensive seed or seed spot protection. More efficient chemical repellents must, therefore, be developed before seeding could be recommended.

Mechanical protection devices are generally too expensive to be practical in large-scale seeding operations. Seed spot protection, for example, with wire cages made of $\frac{1}{2}$-inch hardware cloth, 24 inches high and 2.5 feet in circumference costs 50 cents per cage. Smaller cages might, of course, be used but they will greatly increase the danger of seedling suppression with the resulting reduction in growth. Cages made of galvanized wire may be used repeatedly, but in their normal form they are very bulky to transport and when flattened they are difficult to reshape properly to give full protection. Seeding in tin cans is probably the most economical protection method at present. But this method still compares unfavourably with the planting of seedlings in regard to cost and reliability of stocking.

Figure 1 Cumulative per cent germination of black walnut seeded at depths of 2,6, and 10, inches in the autumn of 1963 and the spring of 1964.