SUCCESSFUL ESTABLISHMENT OF SUGAR MAPLE IN A SCOTS PINE PLANTATION

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Frontispiece. Natural sugar maple regeneration under a 45-year-old red pine plantation.

ABSTRACT

Sugar maple (*Acer saccharum* L.) was seeded and planted in a 23-year-old Scots pine (*Pinus sylvestris* L.) plantation near St. Marys, Ontario. Only 2% of the viable seed germinated and 4-year height growth of the established seedlings was only 27 cm (10.53 in.). Four-year survival of the planted seedlings and transplants ranged from 79 to 96%. Four-year height growth of the 2+0 seedlings and 2+1 and 2+2 transplants was 77, 150 and 152 cm (19.6, 38.1 and 38.6 in.), respectively, in plots where two rows of Scots pine were removed for each row left standing.

RÉSUMÉ

On sema et planta de l'Érable à sucre (*Acer saccharum* Marsh.) dans une plantation de Pin sylvestre (*Pinus sylvestris* L.) âgée de 23 ans et sise près de St. Marys, Ontario. Seulement 2% des graines viables germèrent et la hauteur des semis après 4 ans faisait seulement 27 cm (10.53 po). La survie après 4 ans des semis et des plants variait de 79 à 96%. La hauteur après 4 ans des semis 2+0 et des plants 2+1 et 2+2 s'éleva à 77, 150 et 152 cm (19.6, 38.1 et 38.6 po), respectivement, dans les places où on avait enlevé deux rangées de Pin sylvestre pour chaque rangée laissée debout.

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THE PROBLEM

A strong demand exists in southern Ontario for the afforestation of abandoned farmland with sugar maple (*Acer saccharum* L.). Although sugar maple regenerates profusely in hardwood woodlots, it does not grow well when planted on former agricultural land (Yawney 1968). The following reasons have been suggested for this poor performance: (1) failure to choose proper planting sites, (2) competition from field vegetation, (3) repeated damage by late frosts, and (4) animal damage (Wallihan 1949). However, no conclusive evidence is yet available on the relative importance of these and other factors to sugar maple survival and growth. Investigations are at present being carried out by the Great Lakes Forest Research Centre but until these studies are completed sugar maple afforestation of former farmland cannot be recommended for Ontario.

One way of narrowing the gap in site conditions between open farmland and hardwood woodlot is to plant sugar maple under the canopy of pine plantations. Scattered throughout southern Ontario are large numbers of 20- to 40-year-old plantations of white pine (*Pinus strobus* L.), red pine (*Pinus resinosa* Ait.), Scots pine (*Pinus sylvestris* L.), and jack pine (*Pinus banksiana* Lamb.) planted on former farmland. Where a sugar maple seed source is available, natural regeneration can be found in most of these plantations. Since many pine plantations were planted on sites better suited to the growth of hardwoods than to that of pine and since many of the existing Scots and jack pine plantations are of little commercial value owing to poor stem form and excessive branchiness, a conversion to hardwoods will greatly increase the value of these plantations.

To test the potential of artificial sugar maple regeneration in a pine plantation with no sugar maple seed source, sugar maple was seeded and planted in a Scots pine plantation near St. Marys, Ontario. The 4-year results of this study are presented here.

METHOD

The experimental plantation was planted 23 years ago at a spacing of 5 x 5 ft (approximately 1.5 x 1.5 m). Initially the stand was nearly fully stocked. Mean height of the dominant and codominant trees was 39 ft (11.83 m) and mean diameter was 5.3 in. (13.5 cm). The soil (Perth series: Hoffman and Richards 1952) was an imperfectly drained clay loam over compact clay at a depth of 14 in. (35.6 cm).

In the summer of 1969 the plantation was divided into three equal areas of $\frac{1}{4}$ acre (0.1 ha) each plus surrounds. Area 1 was maintained as a control in which no trees were cut. In Area 2 alternate rows of Scots pine were felled to obtain a reduction in tree numbers of approximately 50%. In Area 3 two rows of pine were cut for each row left standing to obtain a reduction in tree numbers of approximately 66%.

All slash was removed by hand to the edge of the plantation.

In the autumn of 1969 a total of 18 seeding plots of 44 sq. ft (3.96 sq. m) each, grouped in six clusters of three plots each, were laid out in each of the three areas. Three clusters of three plots each were rototilled in each area while the other nine plots received no seedbed preparation treatment. On 28 October, 1969, 250 sugar maple seeds (42% germination capacity = 105 viable seeds) were broadcast over each plot in all three areas. In each cluster of three plots one plot received no post-seeding treatment. A second plot was raked to incorporate the seed into the soil, while in the third plot the seeds were covered with a 2-in. (5.08-cm) layer of red pine needles. One wire cone, 2 ft (60.96 cm) in diameter, was placed in each plot to protect the seed from possible pilferage by birds and rodents. Germination and seedling survival were assessed at 2-week intervals during the spring and summer of 1970 and survival and height were recorded at the end of the fourth growing season.

In the spring of 1970 nine rows of 16 sugar maple seedlings or transplants were planted in all three areas between the rows of pine trees. The average size of planted seedlings and transplants is shown in Table 1. All seedlings and transplants were planted in holes made with a soil auger 10 in. (25.4 cm) in diameter. Survival and growth of

Table 1. Size of planting stock

Age class	Length of stem (cm)	Stem diam. 2.5 cm above root collar (mm)	Oven-dry weight of stem (g)	Oven-dry weight of roots (g)	Top-to-root ratio (oven-dry weight)
2+0	20	4	1	2	1:2.0
2+1	34	7	4	6	1:1.5
2+2	71	16	25	31	1:1.4

all planted trees were recorded after the first and fourth growing seasons (Table 2). The 4-year data were subjected to analyses of variance and Duncan's multiple range test (Steel and Torrie 1960).

Table 2. Four-year survival and mean height of seeded sugar maple

Pine overstorey	No seedbed preparation						Rototilled					
	No post-seeding treatment		Raked		Two-inch[a] cover of pine needles		No post-seeding treatment		Raked		Two-inch[a] cover of pine needles	
	Survival no.	Mean ht (cm)	Survival no.	Mean ht (cm)	Survival no.	Mean ht (cm)	Survival no.	Mean ht (cm)	Survival no.	Mean ht (cm)	Survival no.	Mean ht (cm)
No pine trees cut	-	-	1	18	-	-	-	-	1	42	-	-
Alternate rows of pine cut	-	-	2	16	-	-	9	26	7	29	-	-
Two rows of pine cut for each row left	-	-	-	-	-	-	1	22	1	50	-	-

[a] 1 in. = 2.54 cm.

RESULTS AND DISCUSSION

Germination was poor in all plots and accounted for less than 2% of the total number of viable seeds broadcast on all plots. While the reason for this poor germination could not be ascertained, it is believed that mice ate most of the seeds. Mean height of the established seedlings after 4 years was 27 cm (10.53 in.).

In contrast to direct seeding, planting was highly successful (Fig. 1). Survival of the planted seedlings and transplants ranged from 79 to 96% with no significant differences among age classes of planting stock or canopy densities of the pine overstorey (Table 3).

Figure 1. Sugar maple transplants 4 years after planting in heavily thinned stand.

Table 3. Four-year survival and height growth of sugar maple seedlings and transplants

Age class	Survival			Height growth		
	Control, no pine trees cut (%)	Alternate rows of pine cut (%)	Two rows of pine cut for each row left (%)	Control, no pine trees cut (cm)	Alternate rows of pine cut (cm)	Two rows of pine cut for each row left (cm)
2+0	96	94	92	38	56	77
2+1	83	96	79	47	98	150
2+2	85	92	90	72	88	152

Note: Lines connect means that are not significantly different at the 5% level.

Four-year height growth of transplants was always better than seedling growth and was significantly better for both transplant classes in Area 3 and for the 2+1 transplants in Area 2. While the poorer height growth of the seedlings was probably due, in part, to more severe rabbit browsing of the smaller plants, even those seedlings which were never browsed did not grow as fast as the transplants. Since I obtained similar results in other studies (von Althen, unpublished data) and found in my survey of hardwood plantations in southern Ontario (von Althen 1965) that the only successful sugar maple plantations were established with saplings from nearby woodlots, I am convinced that sugar maple transplants and possibly 3- to 5-year-old, large seedlings are more suitable for underplanting in pine plantations than are small 2+0 seedlings.

The density of the pine overstorey also had a significant effect on height growth of sugar maple seedlings and transplants. The height growth of all age classes of planting stock increased in direct proportion to the reduction in canopy density (Table 3). While the best height growth was obtained under the most open stand conditions, one quarter of the pine trees sustained crown damage in this area from wind and snow. There was no crown damage in the control area and only two crowns were broken in Area 2.

The results of this study show that sugar maple can be established successfully under a Scots pine canopy if the following conditions can be met:

1. removal of 50-66% of the pine overstorey

2. planting of 2+1 sugar maple transplants in the openings created by the removal of the pine trees

3. where necessary, protection of the sugar maple transplants from rabbit and deer browsing.

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