Vegetative Propagation of Yellow Birch From Stem Cuttings

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*Softwood cuttings from yellow birch (*Betula alleghaniensis *Britt.) trees of up to 38 years of age were rooted in a greenhouse under intermittent mist using commercial rooting compounds containing NAA or IBA. Rooting percent varied considerably among clones. Average rooting success over all treatments and conditions with forest-grown trees as the dominant source of cuttings was 23.5 and 17.7% in 1977 and 1978, respectively. Best rooting occurs during July and August, but plants rooted in early summer have the best chance of surviving through the winter in the nursery and being successfully field planted*. Tree Planters' Notes 39(2):37-42; 1988.

Yellow birch (*Betula alleghaniensis* Britt.) is a northern hardwood in considerable demand primarily for veneer and furniture manufacturing. Because of its high value, there has been some effort to study the genetics of yellow birch (2) and its response in plantations (5).

Though vegetative propagation has been tried with many southern broad-leafed tree species, it has not been extensively tested with yellow birch to perpetuate desirable phenotypes (7. Gabriel (4) has rooted yellow birch cutting from trees up to 80 years old, but less than 5% of all cuttings survived the winter and they died soon after budbreak.

Among other birches, Hares (6) reported best rooting success with paper birch (*B. papyrifera* Marsh.) and European white birch (*B. pendula* Roth.) in late summer using 2000 ppm indolebuteric acid (IBA) in solution with a 5-second dip. Dosser and Hicks (3) found early spring was the optimal time for rooting cuttings from river birch (*Betula nigra* L.) and observed considerable tree-to-tree variation (clonal differences) in rooting.

Cesarini and Minamoto (1) rooted European white birch with 1% IBA and Hormodin 3 (0.8% IBA in talc). Vaclav (9) reviewed several techniques used to propagate European birches, including rooted cuttings, and noted good success and rapid rooting with softwood cuttings; hardwood cuttings by comparison took over 2 years to root. Pelham and Mason (8) also reported good success rooting cuttings from European white birch seedlings in an agar medium.

Recent advances in rooting of birches and the steady demand for high-quality yellow birch prompted studies to determine if rooting of yellow birch cuttings, and transfer to nursery transplant beds as an intermediate step to planting, could be achieved.

Materials and Methods

Preliminary trials with hardwood cuttings of yellow birch produced abundant callus but no roots; thus studies were pursued with softwood cuttings from seedlings grown in a greenhouse and in nursery beds and from forest-grown trees.

In the first studies, 2-year-old yellow birch seedlings were dug from nursery beds at the Vermont State Nursery in Essex Junction in January of 1976, potted, and placed in a heated greenhouse. The seedlings broke dormancy soon after transfer, and in April softwood cuttings were taken from both lateral and terminal shoots. Stem diameters of cuttings averaged about 0.1 inch and stem length ranged from 4 to 6 inches, depending on their position on the plant. Most cuttings had 2 leaves and 1 to 2 inches of stemwood below the lowest leaf. Each cutting was immediately dipped about 1/2 to 1 inch into a commercial rooting formulation and inserted about 2 inches into the rooting medium on a greenhouse bench.

Five different commercial rooting compounds were tested during 3 years of study: Hormodin 1, 2, and 3, Rootone F, and Strike.[a] The rooting medium was

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Hormodin 1 = 0.1% indole-3-butyric acid; Hormodin 2 = 0.3% indole-3-butyric acid; Hormodin 3 = 0.8% indole-3-butyric acid; Rootone F = .067% 1-napthyleneacetic acid, .003% 2-methyl-1-napthyleneacetic acid, .013°/ 2-methyl-l-napthaleneacetamide, .057% indole-3-butyric acid with thiram fungicide; and Strike = 1-napthaleneacetic acid, plus captan fungicide (concentration not specified, presumed about 0.5%).

fine gravel passing a ¼-inch screen and spread 4 inches deep over 2 inches of coarse gravel on a greenhouse bench. Rooting bed temperature was maintained at about 70 °F by a heating coil placed approximately 3 inches into the fine gravel. Mist was used throughout the rooting period. It was initially controlled by a Mist-a-Matic apparatus, then later by an electric interval timer that misted for 5 seconds every 6 minutes. Natural daylight was extended to 18 hours for all phases of greenhouse treatment using fluorescent and incandescent lamps. These greenhouse and rooting bed conditions were used for cuttings from greenhouse and nursery-grown seedlings, and forest-grown trees.

Cuttings were examined for rooting once a week. At the first signs of rooting, cuttings were potted in 3-inch-square containers in a medium consisting of 6:3:2:1 ground peat/fine gravel/loam/sand by volume. Osmocote slow release fertilizer (18-6-12) was added at 1.2 g/pot. Cuttings were then placed on a mist bench for 5 to 10 days and watered at half the rate of the nonrooted cuttings. Plants were then transferred to a greenhouse bench and hand watered as necessary.

Cuttings that grew a root System that occupied the pot volume were transplanted into larger pots. Cuttings that developed new shoot growth were transplanted to an outdoor nursery bed under 30% shade provided by slat frames.

During the summers of 1976, 1977, and 1978 (June to September) cuttings were taken at various intervals from nursery seedlings and 34 naturally growing yellow birch trees up to 38 years of age from a wide geographic range in Vermont. Sampling intervals ranged from 7 to 10 days for many trees to only once or twice a season for some small trees, or trees at distant locations. Each collection time (for each tree) was defined as a batch.

Freshly cut shoots were placed in plastic bags with some water and transported in an ice chest to the greenhouse. Shoots were stored in a refrigerator overnight, or immediately retrimmed, dipped about 1 inch into rooting powder, and Inserted in the mist bench. An attempt was made to collect at least 10 cuttings per tree, but small greenhouse or nursery plants often yielded fewer then 10. Two or three cuttings were usually obtained from a new lateral or terminal shoot.

Data were analyzed for rooting percentages using the Duncan's multiple range test.

Results

1976 trials. During the 1976 growing season, 311 cuttings were taken from 18 different greenhouse, nursery, and natural-growing trees and treated with Strike or Hormodin 3. The forest-grown trees were 12, 15, 30, and 35 years old (table 1). Of these cuttings, 294 (94%) produced roots. Among the 18 sources, with repeat batches for some sources, rooting ranged from 50 to 100% and was 100% on the 4 forest-grown trees. Average rooting time (time needed for half the batch to produce at least one visible root)

Table 1—*Summary of softwood cutting results for greenhouse, nursery, and forest-grown yellow birch in Vermont in 1976*

Age of parents (yrs)	Growth regulator	Number of cuttings	Rooting percent	Mean time of initial rootings (days)	% Survival in autumn
2	None	5	100	60	0
2–4	Hormodin 3	51	94	53	29
2–8	Strike	166	90.9	48	26
12–15	Strike	72	100	41	60
30–35	Strike	17	100	45	6

was 48 days and ranged from 21 to 60 days among all sources and collections.

The rooting compound Strike (NAA with Captan) yielded 50 to 100% rooting among the 18 sources and 22 batches tested and 95% rooting overall. Hormodin 3, used on 4 sources yielded 62 to 100% rooting and overall rooting of 94 percent.

Development of cuttings following rooting and potting was variable; some cuttings had additional shoot growth but many showed little change except apparent thickening of the original leaves. In September 103 of 294 cuttings were still alive. Fifty of these having good vigor were transplanted to nursery beds, but only 20 survived the winter and grew well the next summer.

1977 trials. In 1977, 2082 cuttings were taken from 27 greenhouse, nursery, and forest-

Table 2—*Parent tree sources, number of cuttings; and percent rooting by compound for softwood cuttings of yellow birch taken in Vermont during the summer of 1977*

Location of parent in Vermont (Clone No.)	Age of parent (yrs)	Total No. of cuttings	No. of cuttings rooted	Percent of cuttings rooted					
				No Hormone	Rootone F	Strike	Hormodin 1	Hormodin 2	Hormodin 3
Essex Jct. Nursery (1001)	5	24	3			12.5		25	0
Essex Jct. Nursery (1002)	5	36	13				25	38	36
Jericho Nursery (1003)	5	25	0		0	0.0	0	0	0
Jericho (1009)	30	117	28		*20	55	0	22	16
Jericho (NH Source) (1010)	15	92	17		11	88	11	13	
Middlebury (1021)	8	61	3		*0	0	0	9	17
Jericho (1022)	35	129	26		*0	20	0	3	64
Sutton (1023)	30	74	2			0		7	0
Sutton (1024)	15	137	59	50	*27	20	0	64	50
Sutton (1025)	15	138	17			24		6	7
Sutton (1026)	15	163	82	50	*20	71	0	46	43
Jeffersonville (1050)	30	21	0			0		0	0
Sutton (1051)	13	127	52		*0	45	0	41	52
Sutton (1053)	15	109	33			24	0	38	35
Essex Jct. Nursery (1054)	6	78	2	0	*10	10	0	0	10
Middlebury (1055)	9	71	15	67	*11	25	0	19	38
Middlebury (1056)	9	71	15	67	*11	25	0	19	38
Jericho (1057)	15	6	3					50	
Sutton (1059)	30	36	5			0		0	45
Grafton (1061)	20	58	0		0	0	0	0	0
Jericho (1062)	30	169	5		*8	2	0	6	0
Jericho (1063)	30	135	44		*32	63	12	21	42
Jericho (1064)	35	40	12			33		14	60
Essex Jct. Nursery (1065)	3	22	18	64				100	
Jericho (1066)	30	36	2			8		0	8
Jericho (1067)	30	17	0		0		0	0	
Jericho (1068)	30	32	27	83	50		100	86	100
Total or Average		2082	490	44	14.5	26.3	7	30.6	28.4

*Source included in ANOVA.
Rootone F values significantly different from Strike and Hormodin 2 and 3 values (P = 0.072).
Hormodin 1 values significantly different from other hormone values (P = 0.05)

grown trees. Of these cuttings 23.5% developed roots and were potted. Rooting ranged from 0 to 86% among the 27 sources, 70 different batches, and 6 different treatments including a control treatment (table 2). Analysis of data for 5 growth regulators applied to 11 different sources indicated that Hormodin 1 resulted in significantly less rooting than the other 4 regulators, whereas Rootone F yielded more rooting than Hormodin 1 but significantly less rooting at P = .072 (table 2). Only 40 cuttings had new shoot growth after potting. All others died in the greenhouse during the fall and winter. The 40 healthy plants were transferred to nursery beds in August, but few survived the winter.

Among cuttings treated with a growth regulator, best rooting (30.6%) was obtained with Hormodin 2 (158 of 517 cuttings). The lowest rooting (7%) was with Hormodin 1 (14 of 199 cuttings). Rootone F yielded 14.5% rooting (25 of 172 cuttings), Strike yielded 26.3% rooting (135 of 514 cuttings), and Hormodin 3 yielded 28.4% rooting (129 of 454 cuttings). Cuttings from seven trees aged 9 to 38 years were treated with no growth regulator and 28 of 63 cuttings (44%) rooted. These cuttings took considerably longer to root than treated cuttings.

Rooting seems to occur best in mid to late summer. Among cuttings from 5 sources taken after July 1, cuttings treated with no growth regulator averaged 44.4% rooting while those treated with a growth regulator averaged 60.4% rooting.

1978 trials. During 1978 cuttings were taken from twelve trees ranging from about 24 to 38 years in age. These trees were growing on a sandy soil at 700 feet elevation in Jericho Nursery, Vermont and on a stony silt loam soil at about 1800 feet elevation in Duxbury, Vermont. Seven to ten batches of 10 to 20 cuttings were taken from each tree at approximately 1-week intervals between June 7 and August 1. All cuttings were treated with Hormodin 2 (0.3% IBA). Of the 1,396 cuttings taken, 17.7% struck roots and were potted. Average rooting percent by source for the season ranged from 4.6% for a tree at Jericho to 47.2% for the best tree at Duxbury (table 3). Trees 4 and 11 had significantly better rooting than all other trees, and tree 6 rooted significantly better than trees 1 and 7.

Among these 12 trees, only three had maximum rooting occur for cuttings taken during June. Five trees had maximum rooting occur for cuttings taken between July 1 and July 20, while

Table 3—*Data summary and analysis variance for rooted cuttings from 12 yellow birch trees in Vermont sampled during the summer of 1978.*

Tree number	Tree age (yrs)	Total cuttings	Total rooted	Average rooting percent	Mean time of initial emergence (days)
1	32	126	7	5.5	48
2	35	140	20	14.3	42
3	38	136	12	8.8	55
4	25	138	47	34.1	46
5	32	109	14	12.8	48
6	38	110	29	26.4	47
7	36	109	5	4.6	51
8	31	96	9	9.4	45
9	35	109	8	7.3	49
10	30	103	12	11.6	47
11	33	108	51	47.2	46
12	28	112	33	29.5	57
Total/average		1396	247	17.7	48

four trees had maximum rooting occur for cuttings taken after July 20. Within individual sources and batches, some cuttings rooted in 27 days while others cuttings showed no sign of rooting after 80 days and the procedure was terminated.

Discussion

During the last two rooting seasons the misting sys tem failed to work for 2 days in midsummer. Leaves of many cuttings turned bronze during this period, and it appeared all cuttings would be lost. Rooting did occur on about 20% of all cuttings taken, however, and some sources and batches had 100% rooting despite the problem, but lack of water most likely reduced rooting success. Imthese studies cuttings were from plants ranging up to 38 years in age. Cuttings from older plants often do not root as readily as from young plants because they lack juvenility characteristics (10).

Overall rooting the first year was 94% for cuttings from seedlings up to 5 years of age and with no mist failures in the greenhouse, 23.5% the second year, and 17.7% the third year. These differences in rooting are influenced by differences in sources; though some sources were the same each year, differences in physiology were affected by current and past growing season, and by greenhouse environment.

In these studies with yellow birch, cuttings from trees up to 5 years old usually root quite well. Cuttings from trees 5 to 15 years of age seem to have lower rooting potential but do root slightly better than those from trees 30 to 40 years of age. Some trees could be considered good rooters while other trees are comparatively poor rooters, despite age or hormone used. A successful vegetative propagation program may thus depend on identifying desirable phenotypes that are good rooters.

The time of year that yellow birch cuttings are taken has a strong influence on rooting success: best rooting occurs during July and August. Cuttings rooted in late summer, however, are not likely to develop sufficient new growth and may present problems in hardening off for overwintering in nursery beds or a cold greenhouse.

Among the commercial rooting formulations (containing either NAA or IBA) used, Hormodin-2 (0.3% IBA) is judged most effective. Hormodin-3 also yielded good rooting results but the stem section coated with the powder often dies and turns black; rooting occurs above this zone. The rooting powder Strike (containing NAA) also yielded good results but is not readily available. Other rooting powders containing NAA may work equally well.

Results of these studies over 3 growing seasons indicate that softwood cuttings from yellow birch can be rooted with reasonable success using commercial rooting formulations and intermittent mist. Rooting varies considerably among trees, with season, and with plant age. Rooting of cuttings from a single tree may also vary from year to year. There are difficulties in having cuttings break bud to form new growth after rooting and in achieving successful overwintering. Preliminary studies indicate that warm root temperatures obtained by using a heated mat may promote budbreak after rooting. In the end, over 100 yellow birch cuttings survived the greenhouse and nursery phases and are now showing good growth following outplanting on forest sites. Though this percentage of survivors is small, it demonstrates that vegetative propagation of yellow birch by rooting softwood cuttings has potential in genetic improvement programs, and for intensive management where a few stems per acre of selected clones may be planted on highquality sites.

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