THE PROPAGATION OF LARIX FROM SOFT-WOOD CUTTINGS

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Introduction

Any forest tree improvement program, whether It be approached through provenance testing or through plant breeding, has as its aim the selection of fast-growing, disease-resistant and well-formed individuals which are de signated as "elite" trees. Before these elite trees can be evaluated it is necessary to obtain enough clonal propagation to place an adequately replicated experimental planting in a field test where each clone may be compared with all the others. Such clones may be established by grafting or by soft-wood cuttings. Clonal material of larch is usually established by grafting (5, pp. 181-182; 6, p. 395). However, if grafts are used the question of the influence of root-stock upon the scion material is ever present. It, therefore, seems logical to propagate the elite trees through cuttings.

Hyun (1.) rooted cuttings from 10-year-old Larix kaerapferi by soaking the cuttings in a solution containing indoleacetic acid (IA), indolebutyric acid (IB), a-naphthalene-acetic acid (NA) and vitamin B_1 for 24 hours. He found that thirty cuttings treated on March 23 gave 6.3 percent rooted cuttings. On March 26, twenty-five cuttings were soaked in each of the following solutions: (a) IA 40 p.p.m., IB 40 p.p.m.., vitamin B_1 10 p.p.m., vita min B_6 10 p.p.m., nicotinic acid (N) 10 p.p.m., glucose (G) 10 p.p.m., sucrose 2.5 percent; (b) NA 70 p.p.m., vitamin B_1 10 p.p.m. vitamin B_6 10 p.p.m., N 10 p.p.m., G 10 p.p.m., sucrose 2.5 percent; (c) vitamin B_1 10 p.p.m., vitamin B6 10 p.p.m., N 10 p.p.m., G 10 p.p.m., sucrose 2.5 percent. Sixteen, 12 and 8 percent of rooting, respectively, were obtained on Sep tember 25 from these treatments. Sixty cuttings collected on March 17 and treated with IA 20 p.p.m., IB 20 p.p.m., vitamin B_1 10 p.p.m., and 5 percent sucrose failed to root.

Kurdiani (4) rooted European larch in 1908 by placing soft-wood cuttings in sand in a cold frame. Frames were covered with glass sashes painted with lime. They were shaded from 10 a.m. to 4 p.m. and were covered at night with raffia mats. The cuttings were watered three times daily. After two or three months 56 to 75 percent rooting was obtained. He concluded that cuttings of Larix europaea rooted more easily than pine cuttings.

Komissarov (3) applied growth substances to Larix sibirica cuttings. By soaking cuttings from 3- and 10-year-old trees in 0.00 to 0.010 percent B-indolylacetic acid for 24 to 48 hours, 85 and 70 percent rooting was obtained, while for untreated cuttings of the same age 20 to 30 percent rooting was obtained from 3-year-old trees and only 10 percent for 10-year-old trees.

Komissarov in an earlier paper (2) reported a difference in the rooting of cuttings taken in June (26 percent) which he described as non-woody and those taken in July (6 percent) which he described as woody. Cuttings soaked in water gave no rooting.

Larsen (5, p. 182) states that "By using soft wood cuttings in the summer, quite a lively root-formation can be obtained, but the difficulty lies in getting good shoot formation and handling the transplantation so that it has not come into general use. Nevertheless good plants can be raised in that way and efforts to devise a satisfactory technique ought to be continued. Propagation by cuttings can present considerable advantages."

The larch improvement program at Boyce Thompson Institute for Plant Research in Yonkers, New York was begun in 1948 About 100 trees of four different species were growing in the Arboretum. The individual trees within a species showed marked differences in size, form and degree of flowering. It was desirable to propagate the slow-growing trees for a comparison with fast-growing ones to determine if this difference in rate of growth is genetically controlled.

Rooting without Mist

From 1948 to 1956 various experiments were made in an attempt to find a suitable method for rooting soft-wood cuttings. Results and information were not consistent. From thousands of cuttings only occasional roots were formed. The regular greenhouse bench as well as a Wardian case in the greenhouse or in the field was tried without success. Arasan (tetramethylthiuram disulfide) and Spergon tetrachloropbenzoquinone) in the medium did not prevent rooting. In these experiments, mannitol sucrose, lactose, and dextrose were ineffective. Cuttings in a cold frame sealed with polyethylene and provided with partial shade failed to root.

Rooting with Mist

Materials and Methods

In August, 1956 a Watco mist control unit supplied by the Water Cooling Corporation of New York was installed in the greenhouse bench. This was set to provide six seconds of mist every six minutes. Cuttings were placed in sharp builder's sand, firmed and thoroughly watered. No further watering was necessary. An inch of coarse gravel underneath the sand provided drainage. The greenhouse glass was painted for shade. Cutting types included soft wood from terminal and lateral growth and were from four to six inches in length. In summer when growth was extended two cuttings were made from each terminal and each lateral shoot. The basal portions are designated as terminals and laterals and tips from terminal and lateral cuttings are called terminal and lateral tips throughout this report. Hormodin powders 1, 2, and 3 obtained from Merck & Co., Inc., Rahway, New Jersey were applied uniformly as dusts to the basal ends of cuttings at the time of planting.

Cuttings were obtained from species and hybrids of different ages which include Larix decidua Mill., L. leptolepis Gord., L. laricina Koch, L . Gmelinii Litvinov, L. eurolepis Henry (hybrid) and over a hundred hybrid seedlings produced at Boyce Thompson Institute.

Results

1956- In 1956 a total of 3,161 terminal cuttings were taken from five classes of larch which included L. decidua L. leptolepis, L. euroleDis (hybrid) and L. Gmelinii. These trees were eight years old from date of

seed planting. Cuttings were made in August and September and were placed in three types of media which included sand, one-half sand and one-half peat, and a mixture of sand, peat and sphagnum in equal parts. Some were treated with Hormodin 3 and others were not treated. Of these cuttings 261 (8 percent) rooted. These data indicate that cuttings of L. leptolepis rooted somewhat more frequently than those from the other classes. Cuttings taken in August gave better rooting than those taken in September. Cuttings in sand and the mixture of sand, peat and sphagnum rooted better than those in sand and peat. Hormodin 3 stimulated rooting.

The 455 cuttings from trees 29 years of age gave only 1 percent root ing while the 497 from younger trees (6 to 7 years old) gave 12 percent rooting.

Mallet cuttings showed poor rooting. On the other hand, 12 to 21 percent of the tips of terminal and lateral cuttings formed roots.

1957. In 197 a total of 9,563 cuttings were placed under mist and 1,124 rooted (12 percent). These cuttings were from trees of different ages as well as of various species and hybrids. Cuttings were of different types, received different treatments and were taken during May, June, August and September. Rootability of cuttings depends on all of these factors and probably many more which have not been investigated up to the present time.

Age is a very definite factor which influences the rooting of softwood cuttings. The highest percentages of rooting were obtained from 2- to 4-year-old seedlings and the least rooting was with cuttings from 27- to 30--year-old trees as shown in table 1. Among the 8-year-old trees one L. leptolepis seedling gave excellent rooting.

Of the 380 cuttings from thirteen 7-year-old trees only 40 rooted (11 percent). However, if we consider only those treated with Hormodin 3, cuttings from 7 of the 13 trees gave above 28 percent rooting with a maximum percentage of 7.

Since the largest number of cuttings in any one age group was 7,226 from 9-year-old seedlings, these data are summarized in table 2. These were from 32 different trees which represent four species and one hybrid. Terminal cuttings of L. decidua gave no rooting. There was no significant difference in the rootability of cuttings from trees of the other species or the hybrid, L. eurolepis. However, individual trees within a species varied from 1 to 20 percent for L. leptolepis and from 1 to 22 percent for the hybrid L. eurolepis.

These cuttings were also taken during four different months including May, June, August and September as shown in table 3. Cuttings taken in May gave better rooting than those taken in June. The higher percentages of rooting obtained in August and September were due in part to the material, some of which was from younger trees. The higher percentages of rooted cuttings for individual trees may be seen in table 4 where data from the five trees from which best rooting was obtained during each of the four months are tabulated. Sixteen different trees supplied material for these tests. With the exception of three (numbers 4, 5 and 16) these were either L. leptolepis or the hybrid, L. eurolepis. Cuttings from L. decidua, L. Gmelinii or L. laricina were never among the top five lots in rooting ability. Four trees (numbers 3, 81 9 and 10) rated among the five best sources of cuttings for two different months.

Table 1.--Effect of age of Larix trees on the rooting of soft-wood cuttings, 1957 tests

Age of trees Years	No. of cuttings	No. rooted	Percent rooted
27 to 30	814	54	7
9	7226	724	10
8	381	54	14
7	380	40	11
4	538	171	32
3	166	59	36
2	58	22	38

Table 2.--Rooting of cuttings from different species nine-year-old trees

Species	No. of trees	No. of cuttings 1/			Percent rooted 1/		
		Ter.	Lat.	Total	Ter.	Lat.	Total
L. decidua	5	230	-	230	0	-	0
L. leptolepis	16	1868	2447	4315	10	12	11
L. × eurolepis	9	877	1636	2513	10	9	9
L. Gmelinii	1	56	-	56	11	-	11
L. laricina	1	53	59	112	11	12	12

1/ Ter.=terminal. Lat.= lateral

Table 3.--Rooting of cuttings taken from Larix trees at different times during the growing season

Month of cutting	No. of trees	No. of cuttings 1/			Percent rooted 1/		
		Ter.	Lat.	Total	Ter.	Lat.	Total
May	26	523	1018	1541	10	11	11
June	32	1400	1688	3088	6	7	6
August	25	1158	937	2095	18	17	18
September	30	1611	1228	2839	16	11	14

1/ Ter.=terminal. Lat.=lateral

Table 4.--Highest percentages of rooting obtained from cuttings taken from five trees in four different months

Month of cutting	Species or Hybrid	Tree No.	No. of cuttings			Percent rooted		
			Term.	Lat.	Total	Term.	Lat.	Total
May	L. leptolepis[1]	1	18	32	50	50	66	58
	L. leptolepis	2	15	20	34	53	20	34
	L. leptolepis	3	-	86	86	-	20	20
	Hybrid[2]	4	20	40	60	5	25	18
	Hybrid[3]	5	21	-	21	33	-	-
			74	178	252	34	34	30
June	L. leptolepis	6	68	38	106	13	29	19
	L. leptolepis	7	21	106	127	24	12	14
	L. eurolepis	8	37	59	96	16	12	14
	L. eurolepis	9	26	-	26	39	-	39
	L. eurolepis	10	22	-	22	32	-	32
			174	203	377	21	15	18
August	L. leptolepis	11	48	14	62	54	14	45
	L. leptolepis	12	72	70	142	28	30	29
	L. leptolepis	3	98	29	127	13	52	22
	L. eurolepis	13	74	142	216	34	25	28
	L. eurolepis	10	20	-	20	65	-	65
			312	255	567	31	29	30
September	L. leptolepis	14	88	124	212	7	34	23
	L. eurolepis	8	59	118	177	41	25	31
	L. eurolepis	9	44	-	44	50	-	50
	L. eurolepis	15	60	-	60	60	-	60
	Hybrid[4]	16	20	-	20	70	-	70
			271	242	513	38	30	34

[1] L. leptolepis × L. leptolepis
[2] L. decidua × L. leptolepis murrayana Maxim.
[3] L. eurolepis × L. leptolepis murrayana Maxim.
[4] (L. leptolepis × L. occidentalis) × L. leptolepis

Table 5.--Effect of Hormodin powders on rooting of cuttings from Larix trees of different ages

Age of trees Years	No. of cuttings treated[1] Ck.	H_1	H_2	H_3	Percent rooted[1] Ck.	H_1	H_2	H_3
27 to 30	215	198	203	198	2	3	11	11
9	2828	793	814	2791	5	4	6	18
7 to 8	273	91	99	298	3	14	16	20
3 to 4	347	10	10	337	28	50	20	38
2	29	-	-	29	38	-	-	38

[1] Ck.= cuttings not treated. H_1, H_2, H_3 = cuttings treated with Hormodin powders 1, 2 and 3 respectively.

Table 6.--Effect of age of Larix trees upon the rooting of soft-wood cuttings (1958 Tests)

Age of trees Years	No. of trees	No. of cuttings	Percent rooted Average	Low	High	No. of trees above average
28 to 31	5	80	24	4	53	2
10	27	2287	23	5	46	13
8 to 9	31	1155	22	3	54	15
4 to 5	30	1165	35	3	95	12
3	12	180	35	5	90	5
2	3	60	17	5	30	1

Since earlier experiments indicated that Hormodin stimulated better root development some of these cuttings were treated with Hormodin powders 1, 2 and 3 before planting while others were not treated and served as controls. These data substantiate the earlier findings as shown in Table 5© Cuttings from all seedlings 3 to 30 years of age showed stimulated rooting with Hormodin treatment. The rooting of cuttings of more mature wood taken later in the season (August and September) from 9-year-old trees was increased from 8 to 31 percent by the use of Hormodin 3. On the other hand, cuttings from very young seedlings (2 years old) rooted equally well with or without hormone treatment.

Hormodin was effective on cuttings from eight different 3- and 4-year old hybrid trees which gave an average of 33 percent rooting, though the individual trees varied from 12 to 60 percent. Tips from terminal cuttings rooted better than the basal portion of the cuttings (45 and 21 percent, respectively). The highest percentage of rooting for terminals of any individual plant was 40 while 83 percent of terminal tips rooted, Again, in hybrids as in species noted above, cuttings from 2-year-old trees did not require Hormodin for rooting.

1958. -- In the 1958 tests rooting up to 13 percent was obtained in L. decidua cuttings while all cuttings taken from this species in 1957 failed to root. In general, however, results of the 1958 trials were in agreement with those of the previous year.

A total of 13,502 cuttings were placed under mist to obtain material for clonal field tests. The methods were the same as those employed in 1957. Rooting was obtained from 108 different trees as shown in table 6. Eleven of these trees gave from 75 to 100 percent rooting while 33 others gave above 50 percent rooting. Summaries of these data for 1958 substantiate the following facts as shown by previous data: cuttings from trees of different species varied in their ability to root; individual trees within the species also varied in the number of rooted cuttings; cuttings treated with Hormodin 3 gave best rooting.

Larch trees exhibit considerable heterosis as early as their second year and at 10 years of age from seed there is conspicuous segregation into height classes. For example, the height of Larix decidua seedlings ranges from 13 to 23 feet; L. leptolepis 23 to 38 feet; L. eurolepis 23 to 38 feet; and L. laricina 6 to 21 feet. Thus, by the time the cuttings become more difficult to root, due to age of the trees, individuals are already well segregated so that superior trees can be selected with a considerable degree of accuracy.

Summary

Cuttings used in the propagation experiments were from trees of Larix decidua Mill., L. leptolepis Gord., L. laricina Koch, L.Gmelini1 Litvinov, L. eurolepis Henry (hybrid) and from unnamed hybrid seedlings produced at Boyce Thompson Institute.

From 1948 to 1956 various experiments were made in an attempt to find a suitable method for rooting soft-wood cuttings of larch. Only occasional rooting took place in a conventional greenhouse bench or in a Wardian case. Sugars and fungicide treatments proved ineffective. Success was attained in 1956, 1957 and 1958 tests by the use of a Watco mist control unit installed in the greenhouse. Sand was used as a rooting medium. Two- to 4-year-old trees furnished best cutting material and least rooting was obtained from cuttings from 27- to 30-year-old stock. Treatment with Hormodin 3 promoted rooting of cuttings from all trees above 4 years of age. Cuttings taken in August and September proved superior to those taken in May or June. Tip cuttings from terminal shoots rooted more easily than the basal portions.

These findings now make it possible to secure enough cutting material for clonal field tests.

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Figure 1.

Larix cuttings rooted with mist. A, B, tips of terminal cuttings and C, D, mid-section immediately below tip from Larix leptolepis 9 years of age. E, F, G, terminal tips and H, I, J, lateral tips from hybrid (L. leptolepis murrana X L. eurolepis) years of age, respectively (x 0.28).