PROPAGATION OF *TSUGA CANADENSIS* CULTIVARS: HARDWOOD VERSUS SOFTWOOD CUTTINGS

PETER DEL TREDICI

The Arnold Arboretum
Jamaica Plain, Massachusetts 02130

REVIEW OF LITERATURE

According to the literature, the main factors affecting the rooting ability of *Tsuga canadensis*, the Canada hemlock, are the time of year when the cuttings are taken and the type and concentration of auxin used. With regard to proper timing, the literature is ambiguous. Thimann and Delisle (12) had success with rooting both the species and the cultivar Pendula in October and December. Deuber (3) had good success rooting cuttings of the species in November, and Jenkins (9), in reporting the works of nurserymen, variously recommended March, July, December, and August. In 1941, Doran (4) reported success in rooting cuttings from a species plant as well as the cultivars Pendula and Minuta at all times of the year, except early summer. In a later work (5), with the species, he narrowed his recommendation down to any time from mid-August to late January. Swartley (10) recommended February as the optimal time, provided bottom heat was available. In 1984, Swartley (11) modified this recommendation to say flatly that, "the date of taking the cuttings does not seem to be at all critical . . ." Data presented by other authors does not support this lack of specificity. In a 1971 study on an unnamed semi-dwarf hemlock cultivar, Flint and Jesinger (6) came to the conclusion that cuttings taken January through April were comparable with each other and superior to those taken July through October. The author's own research results (2) with 'Pendula' indicated that summer softwood cuttings under mist rooted as well as winter hardwood cuttings, and always better than those taken in the early fall. This paper expands my earlier research to include 8 different clones of *Tsuga canadensis* and focuses solely on the effect of the time of year when cuttings are taken on their ability to form roots.

MATERIALS AND METHODS

All cuttings consisted of wood in its first year of growth, from 2 to 8 months old except for 'Minuta' and 'Pygmaea' which contained 2-year-old wood. The cuttings were taken at 4 different times of the year: 14 July 1980, 1 January 1981, 10 December 1984, and 2 July 1985. In all cases the cuttings were taken and stuck on the same day they were collected. The cuttings varied in length from 1 to 5 in., depending on the cultivar. Eight different individuals of *T. canadensis* growing at the Arnold Arboretum were experimented with: a species tree (50 ft high), 'Ashfield Weeper' (902-69), 'Bradshaw' (634-48), 'Colé' (12-80), 'Minuta' (1068-62), 'Nana' (507-62), 'Pendula' (1514-2) and 'Pygmaea' (955-70-A). In addition, a 120 year old specimen of Sargent's weeping hemlock ('Brookine'), (1), growing outside the Arnold Arboretum, was used.

The lower third of each cutting was stripped of its needles and was quick-dipped for 5 sec in a 1% IBA solution (IBA dissolved in 50% ethanol). In an earlier study (2) 1% IBA proved to be the most effective concentration for inducing roots and was selected for this study.

Following the auxin treatment, the cuttings were inserted into a rooting medium consisting of fine sand and medium perlite (1:1,v/v). Cuttings taken in July were placed under intermittent mist (2½ sec every 2½ min during daylight hours) in a greenhouse at ambient temperature. Cuttings taken in January were stuck in sealed, polyethylene covered frames in a greenhouse with a minimum temperature setting of 55°F (7). In both cases, mist as well as polyethylene, the cuttings received constant bottom heat of 70°F. The cuttings were evaluated for rooting after 4 months. No attempt was made to rate root systems. The fact that there was little difference in the survival rate of well-rooted versus poorly-rooted cuttings also argued against the value of quantifying the root system.

RESULTS

Only in the case of 'Pygmaea' did the summer cuttings root better than the winter cuttings (Table 1). In the case of the two weeping hemlocks, 'Pendula' and 'Brookline,' the summer and winter cuttings both rooted at 50%. With the other 6 clones the winter cuttings all showed superior rooting.

In attempting to apply these results to nursery practice, it should be kept in mind that the softwood July cuttings were potted up in November and passed the winter in cold storage, while the hardwood January cuttings were not potted up until April and received no chilling period. As a consequence of this different timing, the summer softwood cuttings made excellent growth the spring following rooting, while the hardwood winter cuttings made little or no new growth. These weak hardwood cuttings did not really grow until the second spring following rootings. This confirms the observation of Gray (8), who noted that two-thirds of December-rooted cuttings failed to grow out the following spring. Thus, a difference of six months in the time of taking cuttings resulted in the loss of a full year's growth. The softwood cuttings offer a further advantage in that they require no supplementary heat, while the hardwood cuttings required an ambient temperature of 55°F as well as bottom heat throughout the winter.

Table 1. Rooting behavior of hardwood versus softwood cuttings in selected cultivars of *Tsuga canadensis.*

Cultivar	Number of cuttings rooted	
	July[1]	January[2]
Control (Species 50 ft. tree)	3/10	6/10
'Ashfield Weeper' (902-69)	8/10	10/10
'Bradshaw' (634-48)	0/10	1/10
'Pendula' ('Brookline' original plant)	5/10	5/10
'Cole' (12-80)	5/10	10/10
'Minuta' (1068-62)[3]	12/20	15/20
'Nana' (507-62)	4/10	10/10
'Pendula' (1514-2)	7/10	7/10
'Pygmaea' (955-70-A)[3]	19/20	17/20

[1] Number of cuttings that rooted out of 10 cuttings stuck 14 July 1980; treated with 1% IBA; placed under mist.

[2] Number of cuttings that rooted out of 10 cuttings stuck 1 January 1981; treated with 1% IBA; placed under polyethylene tent.

[3] In the case of 'Minuta' and 'Pygmaea', summer cuttings were taken on 2 July 1985 and winter cuttings on 10 December 1984. Also, because of the small size, cuttings consisted of 2-year-old wood.

DISCUSSION

When looking at the complex equation of *profitability*, it is important to consider the issue of *survivability* of cuttings along with their *rootability* in deciding when to take cuttings. It may also be that by sticking the softwood cuttings in an outdoor Nearing frame, as the late Don Smith did (11), one might get better rooting results than this author did under mist.

In conclusion, every clone of *T. canadensis* behaves differently and needs to be investigated individually in order to determine the most effective time of year for taking cuttings. The only point that needs to be stressed is that softwood cuttings of *T. canadensis*, and perhaps other conifers, might well prove to be the most economical way to produce healthy plants.

CUTTINGS VERSUS GRAFTS

While most propagators would agree that cuttings are the preferred method of propagation when it comes to dwarf conifers, there are still a number of nurseries that graft *T. canadensis*. A large part of the reason for this is that grafted plants reach saleable size much more quickly than rooted cuttings. While this is understandable from an economic point of view, it is unconscionable from a horticultural viewpoint, given the ease with which hemlocks can be rooted.

The data in Table 2 shows clearly that hemlocks are no different than apples in that the rootstocks can dramatically affect the height growth of the plant. Grafted plants of 'Cole' were three times taller than rooted cuttings after 4 years, and grafts of 'Nana' were over five times the height of the rooted cuttings after 4 years. This phenomenon has been noted by many propagators in the past, but for dwarf conifers it has seldom been documented with hard data.

Table 2. The effects of cuttings -versus- grafts on the growth rate of *Tsuga canadensis* cultivars (Cole and Nana).

'Cole' (AA 12-80)	
6 grafts (March 1981)	9 cuttings (January 1980)
Av. height (June 1984): 18 cm Av. width (June 1984): 25 cm	Av. height (June 1984): 6 cm Av. width (June 1984): 21 cm
'Nana' (AA 507-62)	
5 grafts (March 1981)	9 cuttings (July 1980)
Av. height (June 1984): 51 cm Av. width (June 1984): 64 cm	Av. height (June 1984): 10 cm Av. width (June 1984): 25 cm

In the case of certain dwarf conifers, then, mutations in the root system may be as much a part of the reason for the slow growth and congested habit as mutations in the shoot system. No doubt, a good deal of the confusion that is endemic to dwarf conifer nomenclature has to do with the differences in appearance that a cultivar can have depending upon whether it was grafted or rooted.

LITERATURE CITED

1. Del Tredeici, P. 1980. Sargent's weeping hemlock reconsidered. *Arnoldia* 40: 202-224.
2. Del Tredici, P. 1983. A giant among the dwarfs — The mystery of Sargent's weeping hemlock. Theophrastus, Little Compton, R. I.
3. Deuber, C.G. 1940. Vegetative propagation of conifers. *Trans. Conn. Acad. Arts and Sci.* 34: 1-83.
4. Doran, W.L. 1941. The Propagation of some trees and shrubs by cuttings. *Mass. Agr. Exp. Sta. Bull.* 382.
5. Doran, W.L. 1952. The vegetative propagation of hemlock. *Jour. Forest.* 50: 126-129.
6. Flint H. and R. Jesinger. 1971. Rooting cuttings of Canada hemlock. *The Plant Propagator* 17 (1): 5-9.
7. Fordham, A.J. and L. Spraker. 1977. Propagation manual of selected gymnosperms. *Arnoldia* 37: 1-88.
8. Gray, H. 1958. *Tsuga canadensis* from cuttings. *Proc. Inter. Plant Prop. Soc.* 8: 166-167.

9. Jenkins, C.F. 1936-1947. *The Hemlock Arb. Bull.* Nos. 16, 17, 26 and 60.
10. Swartley, J.C. 1950. Directions for rooting and growing of hemlock cuttings. *The Hemlock Arb. Bull.* No. 69.
11. Swartley, J.C. 1984. The Cultivated Hemlocks. Timber Press. Portland, Oregon.
12. Thimann, K.V. and Delisle, A.L. 1939. The vegetative propagation of difficult plants. *Jour. Arnold Arbor.* 20: 116-136.
13. Thimann, K.V. and Behnke-Rogers, J. 1950. The Use of Auxins in the Rooting of Woody Cuttings. Maria Moors Cabot Foundation, Publ. No. 1, Harvard Forest, Petersham, Mass.

Thursday Morning, December 12, 1985

The Thursday morning session convened at 8:00 a.m. with Everett Emino serving as moderator.

OVERWINTERING LINERS IN A WELL-WATER HEATED STORAGE STRUCTURE[1]

JAMES R. JOHNSON[2]

Cumberland County Agricultural Extension Service.
R.D. #1, Morton Avenue
Millville, New Jersey 08332

Abstract. A quonset nursery overwintering structure was built using a floor which was heated with 55 to 55.5°F well water as the heat source. The structure was covered with milky-colored, air-inflated polyethylene.

Medium temperatures during two study periods dropped only to 29°F with a typical minimum difference of 2.1° over a normal unheated overwintering structure. Preliminary liner observations showed some benefit with *Euonymus alata* 'Compacta' and *Rhododendron* 'Hino Crimson', but none with *Ilex crenata* 'Hetzii' which was successfully overwintered in both structures.

REVIEW OF LITERATURE

Polyethylene covered structures have been used successfully to prevent desiccation of overwintered nursery stock and reduce temperature fluctuation (1) for many years. The absolute cold that roots experience is also a controlling factor to successfully overwinter plants. In an effort to maintain higher temperatures, the use of air-inflated double milky polyethylene has been shown to be beneficial (5). While killing temperatures for many plants do not occur until 23°F (2), it has been shown that young roots can be injured at 27°F (6). Since temperatures of the growing medium can easily drop below these injury levels even in storage structures, an overwinter-

[1] Supported by a grant from the New Jersey Association of Nurserymen.
[2] County Agricultural Agent.