the cut surface of the graft union until they can form callus. You could cover the union with wax or plunge the graft in moist peat moss, both of which require a lot of materials and handling. We like to cover the grafts with poly because it saves us that labor.

ED MEZITT: Is the dryness of the root as important with evergreen conifers as deciduous conifers? The reason I am asking this is because we have observed with blue spruce a quick death of many of the roots and are wondering if they are too wet.

BRIAN HUMPHREY: I cannot give you a precise answer. My suspicion is that it is as important. My advice is that for any plant you are grafting, try to keep the rootstock on the dry side.

VEGETATIVE PROPAGATION OF ELMS BY GREEN CUTTINGS

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Abstract. Semi-lignified green stem cuttings of several elm clones were successfully rooted in containers under specially prepared tented frames, without a misting system and chemical treatments. The cuttings were collected from vigorous sprouts produced on grafted stools. Clonal variation in rooting was observed.

In the early 1930's, when Dutch elm disease (*Ceratocystis ulmi* (Buism.) C. Mor.) was discovered in North America, programs were initiated to develop resistant elms for future use. American elm (*Ulmus americana* L.) was the most extensively planted species and tree selections of disease resistant individuals were made throughout North America. In Holland, where the disease appeared earlier, disease resistant hybrid elms were developed and released for planting and testing to several European countries as well as to North America. The vegetative propagation of these trees was necessary to raise stock for breeding arboreta, plantation trials and for resistance-testing.

Elms can be propagated by cuttings, but results vary. The propagation of dormant root cuttings can be satisfactory with some elm species (1,5). Experiments with rooting stem cuttings were carried out in different countries (2,3,4). The rooting of semi-lignified and softwood stem cuttings appeared to be more

successful than the rooting of lignified cuttings (5,6,8,9). Chemical treatments of cuttings and of rooting media improved root development (7). In most cases mist was required for successful rooting.

Following is a method for rooting semi-lignified green cuttings of elms without a misting system and without chemical treatments.

MATERIALS AND METHODS

Semi-lignified green cuttings of several elm species and hybrids (Table 1) were vegetatively propagated in containers under specially prepared tented frames both in the nursery and in the greenhouse. The trials were conducted at the experimental grounds of the Ontario Forest Research Centre, Maple, Ontario, Canada.

Table 1. Percent rooting of selected *Ulmus* clones.

Clone No.	Origin*	No. of Cuttings Planted in Trials 1	2	Percent Rooted
U 3	*U.* × *hollandica* Klemmer	32		78
U 6	*U.* (*U. glabra* 'Exoniensis' × *U. wallichiana*) × (*U. hollandica* 'Vegeta' × *U. carpinifolia*) - complex Dutch hybrid.	32		78
U 7	*U. japonica*, Japan	32	51	52
U 8	*U. japonica*, Japan	32	21	41
U 9	*U. japonica*, Japan	32		28
U 10	*U. pumila*, Japan	32		43
U 11	*U. pumila*, Japan	32		59
U 13	*U. americana*, Minn.		13	62
U 14	*U. americana*, Iowa	32		50
U 15	*U. americana*, Iowa	32	39	70
U 17	*U. americana*, Iowa	32	40	54
U 19	*U. americana*, Iowa		28	56
U 20	*U. americana*, Iowa		79	46
U 22	*U. americana*, Wisconsin		31	55
U 22	*U. americana*, Wisconsin		31	55
U 23	*U. americana*, L-235		13	30
U 24	*U. americana*, Wingham		10	0

* Clone U-24 is from Ontario, U-23 from Quebec (source G. Ouellet). The rest of the clones were obtained from the D. Lester, Madison, Wisconsin collection.

The cuttings were collected from vigorously growing grafted stools. The grafts were made by cleft grafting scions of selected elms on the stock of chinese elm (*U. parvifolia* Jacq.) seedlings. Stools, exhibiting vigorous sprouting, were created by cutting back the well established scion grown to just above the grafting level.

The cuttings consisted of the current year's growth and were of semi-mature wood. If soft, unlignified cuttings were taken, they sometimes wilted and decayed. The cuttings were

5-10 cm (2-4 inches) in length, with one or more leaves attached. The large leaves (5 cm or more in diameter) on the cuttings were cut in half, primarily to make planting easier in a confined area.

The soil medium was relatively coarse to enable good drainage. The styrene tubes[1] contained a 1:1 mixture of medium grade vermiculite and peat moss. The Jiffy pots[2] (No. 7) contained peat.

The cuttings were rooted in a protected environment under tented rooting frames. The tent was made of a plastic cover, placed on a quonset type wood frame, approximately 50 cm (20 inches) high, 90 cm (3 ft.) wide and 1.8 m (6 ft.) long. Wood was preferred for the frame, because of its moisture holding qualities. No artificial lights were used.

The leaves were kept moist by watering manually with a fine mist nozzle on a hose. The watering was done occasionally and very lightly, as required (once daily or less). The sterilized sand, on which the containers were placed, was kept continuously moist by bottom watering thus keeping the air humidity within the tent at a high level.

The first of two rooting trials was conducted in the summer of 1977. The cuttings were placed in 2.5 × 7.5 cm (1 × 3 inches) tube-type styrene containers and kept in the tent in a protected shaded area in the nursery. Half of the cuttings were placed on heated soil, the other half on unheated soil. The heating cables were covered with about 7.5 cm (3 inches) of sand and maintained a soil temperature from about 19°C (65°F) to 29°C (85°F); the air temperature inside the tent was similar or slightly higher. On unheated soil the temperatures were 9°C (15°F) cooler. Thirty-two cuttings per clone were planted (Table 1).

The second trial was established in the winter of 1977/78. A tented rooting bed, with soil-heating cables (covered with 5 cm (2 inches) of sand) was built on a bench in the greenhouse. The floor consisted of 7.5 cm (3 inches) of sterilized sand over a plastic sheet or metal pan. The air temperature varied from 18°C (65°F) to 32°C (90°F), and the soil temperature from 16°C (60°F) to 30°C (85°F). The cuttings were placed either in Jiffy pots or in the styrene containers. Thirteen to 79 cuttings per clone were planted (Table 1).

RESULTS

Cuttings rooted in both trials. In all cases (nursery and

[1] Ray Leach Containers, 1787 North Pine, Canby, Oregon 97013, U.S.A.
[2] Stokes Limited, 2729 Jane Street, P.O. Box 10, St. Catherines, Ontario L2R 6R6.

greenhouse, heated and unheated soils, containers and Jiffy pots) similar results were obtained, and the average rooting for all clones and trials was approximately 50%.

The clonal variation in rooting was significant (Table 1). The poorest rooters were clones U-24 (0%), U-9 (28%) and U-23 (30%). The best were clones U-3, U-6 and U-15 (rooting 70 to 78%).

In both trials rooting started approximately 4 weeks after planting and continued for about 8 weeks. The growth of stem buds was a good sign of rooting. Roots developed mostly from the callus formed at the bottom of the cuttings. The one-year-old rooted cuttings showed regular growth without signs of topophysis.

DISCUSSION

The method of vegetative propagation of elms by rooting stem cuttings described in this paper gave good results with most of the clones tested.

The method is simple, it does not require either mist or chemical treatments, and lends itself to large scale application. Good results were obtained even with cuttings originating from mature trees. Possibly the grafting of mature tree scions on young seedling stock and the subsequent management of grafts for vigorous sprouting resulted in producing juvenile cutting propagules.

In the system of stool-sprouting, new green cuttings can be taken from the same stools continuously, as they are produced, throughout the season. Thus, a large number of cuttings can be taken from very few stools in a short time.

The desirable conditions for rooting were with soil and air temperatures from 24°C (75°F) to 29°C (85°F) and with air humidity from 90% to 100%. It was noted that ideal conditions were obtained when the outside temperatures were cooler than inside the tent, as this maintained under the tent a constant high level of humidity without excessive heat.

Elm cuttings were easier to root in the greenhouse, because of the better control of conditions. The hardening-off of greenhouse-rooted cuttings presents no problem. In the greenhouse the growing of potted stools and new grafts for cutting collection is also easier and faster.

Rooting trials indicated the necessity for better media drainage. For future trials either sand and vermiculite, or sand and peat mixtures might be recommended. A bottom layer of a usual growing soil in the container may further facilitate the growth of the rooted plant. Such a plant could then be readily

transferred to either a larger-size pot or to a transplant bed until it has reached outplanting size.

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PROPAGATION BY CUTTINGS OF LILACS AND OTHER HARD-TO-ROOT SPECIES BY THE SUB-IRRIGATION METHOD

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At Weston Nurseries we have been rooting cuttings of lilacs for over 40 years — even before mist systems, polyethylene or rooting hormones were introduced. Our early lilac propagation was done in a pit greenhouse shaded with lath several feet above the glass. With careful supervision and occasional hand watering the cuttings rooted quite satisfactorily, particularly the deeper colored cultivars. In more recent years, we have been rooting lilacs in poly tents or with mist. None of these methods have proven reliably satisfactory for many cultivars, particularly the white ones. Today I would like to explain our sub-irrigation method. This is simply applying water to the cuttings from beneath the rooting medium. Metal pans are the only equipment we use at the end of a greenhouse shaded with 60% saran cloth and shielded from direct sunlight with white polyethylene. The pans (8 ft. × 3 ft. × 6 in.) are filled with ¾ inch stone to a depth of 2 inches and the rest with horticultural-grade perlite.