

in subsequent Proceedings every year for six consecutive years.

I came to know this propagator because his knowledge was freely shared and was of tremendous help to me in my fledgling years as a propagator here in Rhode Island.

He served with me as a member on the Eastern Region Board and has continued to remain active as chairman of various committees, as a moderator, as participant in grafting workshops, and as a presenter of meaningful papers. He is the type of down-to-earth propagator who tells it like it is, who reports on not only the rooted cuttings but on the unrooted and dead ones as well.

Most of you in this room heard his presentation Tuesday on the subject of seed treatments to enhance germination. On Friday, you will enjoy his quick wit as co-moderator for the Question Box. Much like E.F. Hutton, when he talks, people listen!

I am honored and proud to present the 1985 Award of Merit to a good friend and good neighbor from the north, from Sheriden Nurseries in Oakville, Ontario. A warm and appreciative welcome for Joerg Leiss.

Friday Morning, December 13, 1985

The Friday morning session convened at 8:00 a.m. with Mark Widrlechner serving as moderator.

CONTAINERIZED SEEDLING AND ROOTED CUTTING TECHNOLOGY IN SWEDEN

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As are their ornamental cousins of the domestic landscape, species of forest trees are subject to intensive selection and breeding. Genotypes superior in growth rate, disease resistance, wood characteristics, etc. are exchanged among members of forest tree improvement cooperatives. Grafted scions of these genotypes arranged in the field for adequate clonal dispersion and cross pollination grow to become production seed orchards. As more and more seed is collected from orchards,

forest tree nurseries are being stocked increasingly with genetically improved seedlings.

To enhance the development of improved seedlings, nursery culture is intensified. Sites for new bareroot nurseries are carefully selected for soil and water quality. Intensively managed containerized forest nurseries are being established, some with rooted cuttings as well as with seedlings.

As has been the practice in Europe for many years, management of forest nurseries in the U.S. is increasingly being viewed as the prerogative of the horticulturist. Moreover, equipment and methods traditionally used for the propagation and production of ornamental plants are being adapted by forestry nurseries. Greenhouses, for example, are being used in many nurseries to extend the growing season and to reduce production time and to improve the growing environment of containerized seedlings.

In Scandinavia, highly sophisticated nurseries are a result of an overall increase in the mechanization of reforestation that began in the 1970's. To reduce very high labor costs, machine planting of containerized seedlings extends the planting season beyond the colder months. The cost effectiveness of machine planting is increased by using the machinery for more months of the year. In contrast, bareroot seedlings can only be planted in the winter while they are dormant.

The Hiko System is one method of producing and planting high quality containerized forest seedlings. Developed in Sweden in the 1980s, the system has been adapted in France, Austria, Ireland, Canada, and the United States for use with small-seeded species of spruce and pine. Modifications have made possible the manual sowing of large-seeded species and the sticking of cuttings. Use of the Hiko System in conjunction with greenhouses from Finland and computerized climate controls from Denmark has created a very efficient production system at Hillehog Forestry AB in Falconberg, Sweden.

Though numerous types of fiber pots are used in Sweden, the Scandinavian country with the largest forest area, plastic container sets have been used the longest. The basic unit of the Hiko System is the container set, a polyethylene multipot measuring 21×35 cm. Sets have 40 tapered, ribbed, open-ended containers, each of 93 cm^3 . Plants propagated in these containers develop a dense and fibrous root system.

Metal growing frames hold 60 container sets above ground allowing air pruning of roots. Frames may also serve as shipping units for plants and as storage racks for container sets. Storage of frames and sets for 5 million plants grown on one hectare is possible in a compact space 3 meters high by 30

meters square.

Stacks of container sets are fed automatically to the Hiko filling and sowing line and then filled, compacted, and sown in 5 electronically synchronized steps, which occur on 5 sets simultaneously. Growing medium is vibrated into the containers and compacted to 1 kg/cm².

Seed is moved from hoppers by vibration plates to two rotating cams, each with 20 indentations for single seeds. Seed is dropped into 40 tubes leading to the sets. Liquid gel may be added to maintain hydration between the seed and growing medium prior to seed germination.

With a three person crew, one set is completed every 5 sec — or over 20,000 containers are seeded per day. To insure that planting is done efficiently, seed must be very clean and of uniform size. This is accomplished with vacuum cleaning and sizing equipment. Very small seed can be encapsulated to a uniformly larger size and treated with pesticides, mycorrhizae, etc. Seeded container sets are moved by conveyor for automatic loading onto stacked growing frames.

Cuttings of Norway spruce, *Picea abies*, are easily rooted. Sets are filled with pure peat moss in place of the peat and perlite (3:1,v/v) medium used for seedlings. They are diverted to a room where refrigerated cuttings 8 to 10 cm are stuck. About 6,000 can be taken from field or potted hedges and stuck per person each day. Cuttings may be stored for several weeks if the dry weight is at least 30% of the fresh weight. Otherwise they may be stored only a few days. No hormones are used due to strict government safety regulations.

Frames are transported in stacks by forklift to the propagation houses measuring 25 × 114 meters. These are supplied by Kevythalli OY of Finland. Frames are unloaded by articulated hydraulic arms and arranged by seedlot or clone. Houses each take a week to fill with 1.2 million plants. To maximize space utilization, frames of container sets are pushed as closely together as possible. Thinning and transplanting are accomplished by “walking through” the container sets, whereby workers move sets behind themselves as they complete work on each set in front of them. A variety of Hiko traveling boom irrigators provide water. Relative humidity for the cuttings is maintained at 90% and dropped to 65% after rooting.

All fertilizer is applied through the irrigation line after 70% seed germination or after rooting has occurred. Herbicides are also applied in this manner after plants are about 2 months old. During winter propagation, light at 1,000 lux is applied by the boom every half hour to extend the photoperiod.

When the houses are filled, the temperature is gradually

raised to 23°C and then lowered to 20°C after 70% germination or rooting. The atmosphere is enriched to the economic optimum of 1500 ppm CO₂ during daylight hours by injection into the air circulation system.

All climate control is done with a computer from Dansk Gartneri Teknik of Denmark. Sensors monitor all climatic factors continuously and record them every 15 minutes. An office terminal allows instant screen readout and printed records of accumulated daily and weekly data files. Should the programmed limits for any environmental factor be exceeded, sensors linked to alarm systems will detect the changes.

When winter crops of seedlings or rooted cuttings of Norway spruce are large enough, they are transferred to outdoor holding areas for overwintering. Though temperatures fluctuate below the freezing point during the long winter, only a minimal amount of protection is necessary. The growing frames are close to the ground and are pushed closely together. Salmon netting is stretched over the frames to support a spun fiber fabric which is sealed along the sides of the frames. This, along with snow fence protects the plants from wind and allows irrigation to continue throughout the winter.

Though plants may be transported on the growing frames, they are usually shipped in container sets in corrugated boxes with 120 plants per box. A variety of Hiko machine and hand-planting equipment is available that conforms exactly to the particular dimensions of the plug and top size of the plants. Though the equipment is designed for reforestation, it can be easily adapted to the outplanting of nursery liner stock.

Further information on the Hiko System and the greenhouses mentioned herein may be obtained from the author in the United States, or from the following address: Hilleshog Forestry AB, 789 Don Mills Road, Suite 700, Toronto, Ontario, M3C 3L6, Canada.

QUESTION BOX

The Question Box Session was convened at 8:40 a.m. with Ralph Shugert and Joerg Leiss serving as moderators.

MODERATOR LEISS: Question for Dale Deppe. What is your misting nozzle?

DALE DEPPE: A Spraying System 1/4 E10. We operate it at 70 psi. It is available from Spraying Systems.

MODERATOR LEISS: Why do such outstanding nurseries, such as we saw Wednesday, hold to cow manure instead of chemical fertilizers; to hoeing and mule cultivation instead of