CONTRASTING APPROACHES TO CONTAINERIZED SEEDLING PRODUCTION

3. THE MARITIME PROVINCES

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Abstract.--Production facilities and cultural practices for producing containerized tree seedlings in Maritime greenhouses are described. Several systems are in use and some features are contrasted with those in other regions. New container facilities account for much of the expansion in nursery production. Further investigation of crop specifications, seedling hardiness and energy conservation are recommended.

Résumé.--On décrit les installations et les méthodes de culture employées dans les Maritimes pour produire en serre des plants en mottes emballées. Plusieurs systèmes sont employés, et on établit quelques points de comparaison avec d'autres régions. Les nouvelles installations de plants en mottes emballées comptent pour beaucoup dans l'augmentation de la production en pépinière. On recommande d'effectuer d'autres recherches sur les caractéristiques des cultures, la vigueur des plants et l'économie d'énergie.

INTRODUCTION

Containerized seedling production in the Maritime provinces has three main features: the operation of greenhouses in winter, the planting of actively growing seedlings, and the use of an extended planting season. In the early 1970s a two-crop system evolved: a "winter" crop of spruce *(Picea* spp.) is grown in heated greenhouses between December and February for late-spring and early-summer planting; following removal of the winter crop from the greenhouse, a "summer" crop of pine *(Pinus* spp.) is grown for late-summer planting.

More recently, additional summer crops have been grown with the later crops being held over .winter. These crops extend the container planting season because dormant seedlings can be planted in spring before the current winter crop is ready. Undersized crops can be grown for part of another season and summer planted after the winter crop, but before the current summer crop is ready.

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Full-season planting is used by some agencies, except during extreme fire hazard. Actively growing black spruce *(Picea mariana* [Mill.] B.S.P.), red spruce *(P. rubens* Sarg.), jack pine *(Pines banksiana* Lamb.) and larch *(Larix* sp.), i.e., seedlings without fully lignified top growth or dormant terminal buds, are often outplanted. Other species such as white spruce *(Picea glauca* [Moench] Voss) or red pine *(Pinus resinosa* Ait.) usually have set bud at outplanting although seedling dry weight is still increasing rapidly in the nursery.

PRODUCTION FACILITIES

Greenhouses

Initially, free-standing metal-arch greenhouses with a double polyethylene cover were used. Recently, several large gutter-connected complexes with double-poly covers have been constructed. (One new heated complex covered with fibreglass is fitted with heat-shade curtains.) Bay widths vary from 4 to 11 m. The total greenhouse space available for forest tree seedling production in the Maritimes is 5.8 ha, of which 60% is heated for winter production (Table 1). These greenhouses are serviced by headhouses that contain the boiler plant, loading equipment, and space for office, laboratory, and storage.

Greenhouse equipment

Heat is supplied from boiler plants to hot water unit heaters with adapters for duct-vent polytubing under benches or, for most gutter-connected complexes, through aerially mounted finned pipes for radiation heating to melt snow. In 1980, 27% of the 51 million seedlings grown were produced in heated greenhouses at a fuel cost of between $17 and $25 per thousand seedlings.

Most greenhouses are cooled by exhaust fans with motorized inlet shutters; pad cooling systems are used only in research greenhouses. Overhead, duct-vent polytubing with pressurizing fans and motorized inlet shutters provide recirculation of air when the greenhouses are closed, or fresh air for cooling or humidity control during the cold season. When the required cooling exceeds the mechanical capacity of the system, the polycovers are painted with a white latex paint. Some growers are reluctant to use paint on high-grade multiyear plastics, because it is then necessary to use new plastic for the following winter crop in order to provide sufficient natural light for growth. Curtains made from heat shield or shade fabrics have been installed in some gutter-connected complexes.

Greenhouse climate equipment is controlled mostly by programmable systems such as the Wadsworth (Arvada, Colorado) STEP (single total environmental programmer) system. Emergency generators provide electrical backup for winter heating and summer cooling.

The containers are generally placed on raised benches or, in most gutter-connected complexes, on raised pallets for transfer by forklift. Roller benches are also used. At some locations, crops are grown on the ground (total 1.4 ha).

Irrigation in most greenhouses is provided by irrigation carts mounted between benches or suspended from trusses. These are generally Spray-Rite Watering System (Waterford, Ontario) carts with TeeJet (Spraying Systems Co., Wheaton, Illinois) spray nozzles mounted on 31 cm centres, with the boom suspended 40-50 cm above the containers. Fertilization is usually done with liquid fertilizer injectors.

Shadehouses and holding areas

Most greenhouse nurseries use open holding areas, usually covered with crushed rock or gravel to a depth of 15 cm or more, for temporary holding, outdoor growing, or overwintering stock (Table 1). A gravel base provides good drainage and support for equipment. Some nurserymen cut narrow east-west strips in the forest to provide summer shade; these also provide a sheltered overwintering area because of the increased shade and snowcover. Irrigation of stock in such areas is accomplished by means of portable sprinkler irrigation systems with impact sprinklers mounted on risers.

Shadehouses are also used. They are constructed as pole-frame supports of wood or metal with a flat cover of lath snow fence or nylon shade cloth.

Wood frame shelterhouses constructed of 2.5 x 7.5 cm lath boards mounted on 15 cm centres have been used primarily for protection of overwintering stock at two locations which have unreliable snowcover. These shelterhouses are also used for frost protection of winter-grown stock that is moved out-

Table 1. Area of various container greenhouses in the Maritime provinces (m^2)

	Free-standing		Gutter-connected		Open holding area	Shade area
	Heated	Unheated	Heated	Unheated		
New Brunswick	12,000	6,800	10,700	6,000	70,000	10,000
Nova Scotia	3,100	9,500	7,400	Nil	47,500	930
Prince Edward Island	370	Nil	3,700	Nil	500	4,200
Total	15,470	16,300	21,800	6,000	118,000	15,130

side in spring, and as growing facilities during summer months. They are now covered year-round with a single poly cover and, consequently, are considered greenhouses.

Loading Equipment

High-capacity filling and seeding machines are in use at six nurseries. Seven of these machines were constructed by a New Brunswick firm. The machinery includes:

- an electrical control panel;
- a peat shredder and feeding screw; leading to
- a feeder-mixer bin with another feeding screw; leading to the top of
- the filling machine where flats are filled, compacted, and levelled;
- a return conveyor for surplus growing medium from the filler;
- a high-capacity sowing machine with self-cleaning attachment for the nozzles;
- a gritting machine to cover seed.

A dust-control system is available and is used at some locations. Two locations use other seeding machines: one uses a Vancouver Bio-Machine (Surrey, British Columbia), the other a Wendt seeder (Stockjo, Sweden).

Containers

Of the 51 million seedlings produced in 1981, 45% were in Japanese paperpots, 42% in Can-Am multipots, 11% in styroblocks, and 2% in Spencer-Lemaire "Rootrainers" (Table 2). Multipot production is increasing and new sizes are being developed at Can-Am Containers Ltd., Springhill, Nova Scotia. The total number of seedlings shipped from nurseries in 1981 was 73 million; container shipments accounted for 64%.

Growing Media

Most seedlings are grown in peat, although several nurseries use a 3:1 (v/v) peat and vermiculite growing medium. Osmocote (Sierra Chemical Co., Milpitas, California) slow-release fertilizer is used at some locations. Lime, granular fertilizer, and soil wetting agents are not added to the growing medium before it is loaded into the containers, nor is the medium premoistened. Operational problems include variations in medium density, difficulty in wetting the medium for germination, and lack of uniform mixing of the slow-release fertilizer. The peat is usually shredded at the time of loading and, if vermiculite or slow-release fertilizer is added, the mixing process is expected to be completed in the feeder-mixer bin.

The problems referred to above can be reduced by using a premix batch bin. Water is added to premoisten the peat or peat-vermiculite to a desired level. Then, if small volumes of high-density materials are to be added, they can be premixed with some other material which has also been premoistened and transferred to the batch bin for final mixing.

Although the availability of peat has presented some difficulties, the source used in the Maritimes is acceptable, and does not usually exhibit such problems as fineness, excessive debris, or high acidity.

Since the amount of peat used in forest nurseries is only a small portion of that used for horticulture, particularly in the United States, special demands for a quality best suited to containerized tree seedling production are left to the purchaser's discretion. Results of physical (cf. Carlson 1979) and chemical tests on some lots of peat and peat-vermiculite growing media analyzed at the Maritimes Forest Research Centre are given in Table 3.

STARTING THE CROP

Seeding

Usually, the species grown in the Maritimes, such as black spruce or jack pine, germinate acceptably without pretreatment for greenhouse sowing. However, the germination time of white spruce can be reduced by stratification, and the crop is subsequently more uniform. White spruce is stratified by placing layers of seed between layers of moist sand and storing for one or two months at 1-2 °C. White pine (*Pinus strobus* L.) and balsam fir (*Abies balsamea* [L.] Mill.) also germinate better if stratified, but only small quantities of these species are grown.

Seed coatings are not generally used and the use of fungicides at the time of seeding is discouraged unless specific fungi have been identified. Red lead or aluminum powder is sometimes used to make the seed more visible during the sowing operation. When prevention of damping-off is necessary, Captan is used most commonly (5 g/m^2 Captan 7.5D or 0.17 kg/100 m^2 Captan 50W).

Multiple seeding (usually two or three seeds per cavity) is practised to obtain nearly complete stocking. The seed is

Table 2. Containerized tree seedling production in the Maritime provinces, 1981.

Container type	Crop shipped in 1981 from overwintered or current production: Held over winter from 1980 (000,000)	Crop shipped in 1981 from overwintered or current production: Current 1981 (000,000)	Crop held over winter for 1982 (000,000)
Multipot 1	8.1[a]	Nil	7.5
Multipot 2	6.6	1.9	11.7
Styroblock-2	1.4	0.5	1.0
Styroblock-4	Nil	1.8	1.7
Styroblock-8	0.9	0.2	0.2
Paperpot FH 408	4.0	20.2	3.0
Paperpot FH 608	Nil	0.4	Nil
"Rootrainers"	1.1	0.1	1.0
Total	22.1	25.1	26.1
Total crop shipped 1981	47.2		
Total crop produced 1981		51.2	

Table 3. Physical and chemical characteristics of peat and peat-vermiculite growing media.

Physical	Peat	Peat:vermiculite 2:1
Saturated weight (g/L)	630	650
Dry weight after saturation (g/L)	69	96
Ash content (%)	4.7	NA
Bulk density (g/ml)	0.069	0.096
Specific gravity (g/ml)	1.53	1.53
Pore volume (%)	95.5	94
Water capacity by volume (%)	56	55
Air capacity (%)	39.5	39
Coarse:fine ratio	0.48	NA
Drying time (hr at 60°C)	65	40
Chemical		
pH	3.6	5.2
Cation exchange capacity (meq/100 g)	121	160
Exchangeable sodium (meq/100 g)	1.78	NA
Conductivity (mhos x 10^{-5})	19	75
Total nitrogen (%)	0.9	NA

covered with a coarse, inert grit of silica or granite (or even limestone) ranging in particle size from 1 to 4 mm (60-80% in 1-2 mm range; 15-40% in 2 mm range or larger; few fines). The seeded trays or blocks are moved dry to benches in the greenhouse, then soaked to field capacity. They are not covered with plastic or other material.

Germination and Establishment

Temperature and relative humidity

Where heat is provided for germination, the temperature is raised to 24-26°C with 80% relative humidity for 1 to 2 weeks. Light irrigation is carried out several times daily, as required to prevent drying of the seed or, in hot weather, to reduce surface temperatures.

Germination and establishment diseases

In the past, the fungicide Captan was applied at the time of sowing. Now, however, fungicide is not applied routinely during the period of germination and establishment. In fact, no fungicides are recommended unless a problem is specifically identified. Many times, losses blamed on fungal diseases are caused by other environmental factors such as excessive humidity, heat or sunlight, or the use of the fungicide Captan. Losses are reduced by controlling the growing conditions: high humidity and temperature are used only during germination, light irrigation is carried out to ensure complete emergence and to prevent seed caps from sticking, and fertilization is delayed until the third week following emergence. These measures reduce seedling etiolation and succulence.

Thinning

Thinning is done before there is significant root branching but after emergence is complete. Extra seedlings are pulled out by hand, although in some operations where emergence takes place over an extended period, scissors may be used. The crop is irrigated soon after the thinning operation to reduce stress. Thinning costs have varied from $2 to $4 per thousand seedlings.

GROWING THE CROP

Greenhouse Environment

Temperature

Greenhouse temperatures are generally kept between 21 and 24°C on sunny days for spruce, and perhaps at 27°C for pines. The set-point for heating may be only 18°C; therefore, in overcast weather the greenhouse is cooler. Night temperatures vary from 10 to 16°C. For warm weather cooling, shading is necessary, particularly in free-standing polyhouses, and white latex paint can be sprayed on the polyethylene to achieve the desired cooling effect. Where the greenhouse cover will be used more than one year, removable shades should be used rather than paint so that the next winter crop will receive as much sunlight as possible.

Relative humidity and soil moisture content

Relative humidities of 60-80% usually can be maintained year-round in the greenhouse. In hot summer weather, there is adequate humidity for growth at Maritime locations. However, excessive humidities in winter months prevent proper drying of soil and foliage and can result in soil saturation for extended periods, and consequently in reduced growth and root deterioration. This has been a particular problem with paperpot crops, and slow-release fertilizers are now being used to eliminate the need for water. Forced-air under-bench heating effectively warms the medium and evaporates moisture, but complexes with aerially mounted finned tube heating systems do not have this advantage.

Aeration within greenhouses is critical and, as noted earlier, growers are reluctant to reduce humidities to proper levels by using fresh-air systems supplemented by heating.

Lighting

Light requirements to prevent dormancy of black spruce are flexible. Other species like white spruce need supplemental lighting at all times when daylength is less than 14 hr (late August through early April at Fredericton).

Light is provided in several ways. Few nurseries use daylength extension. Rather, supplemental light is supplied by a 1-4 hr night break from strings of incandescent bulbs suspended over benches. Some use an intermittent night break from incandescent or fluorescent lighting mounted on irrigation carts. These travel over the crop taking 2.5 to 5 min to travel one way on a 23-m bench. As little as 5 fc of incandescent light can prevent dormancy of black spruce but dormancy of white spruce can occur with 15-20 fc of light in conjunction with other environmental stresses. Normal lighting intensities vary from 20 to 70 fc. Cart lighting often supplies light intensities of several hundred fc.

Water and Fertilizer Management

Irrigation

Watering carts are generally equipped with TeeJet 8003 nozzles, although some use coarser nozzles for older seedlings and summer watering. Usually, either a double or a coarse nozzle is mounted at the edges of all benches.

The weight of flats is used for water management. A few flats or blocks from different parts of the greenhouse are weighed because of variation due to the depth of grit mulch. For solid-wall containers, water is usually added to the point of drip or near field capacity. For winter crops, particularly paperpots, care must be taken to avoid long periods of saturation. The range of weights used for different containers is: paperpot FH 408, minimum 13.5 kg, maximum 14.5 kg; styroblock-4 and -8, minimum 5.8 kg, irrigate to point of drip.

Irrigation to the point of drip is carried out to reduce the danger of drying from the bottom up, or of individual cells drying in solid wall containers, particularly with underbench heating systems. Problems with such drying and with soil crusting, algae, fungus gnats, and soil salts have resulted from poor irrigation practices.

Fertilizing

In Maritime greenhouses, fertilizer is generally applied weekly as soluble fertilizer in concentrated solution which is watered in, often to the point of drip (ca. 1.1-1.3 kg/100 m^2 in 350 L of water followed by 550 L of rinse). Concentrated fertilizers must be rinsed off foliage to prevent burning. The types of fertilizer used and the rates of application are described in the cultural schedules in the Appendix and are divided according to the stages of seedling development. It should be noted that several growers are using constant fertilization techniques.

In general, the pH of irrigation waters has not been regulated in nurseries, although monitoring of soil pH is continuous. No specific problems have been identified except that certain commercial mixes of peat and vermiculite produce a pH exceeding 6, which causes chlorosis.

Soil fertility is monitored by analyses for pH, conductivity, and concentration of available nutrients (nitrate nitrogen, phosphorus, potassium, calcium, and magnesium). The balance and level of nutrients in foliage, indicators of the success of the fertilization program, are also checked. These factors are described elsewhere in these proceedings (Hallett 1982).

Hardening the Crop

Specific regimes are used to condition seedlings, depending on the next stage of production and whether the crop is in the greenhouse or outside. Supplemental light is shut off; the soil is leached to remove soil nutrients, then dried to develop stress; a high phosphorus and potassium fertilizer is applied; and both high and low temperature stresses are developed as permitted by weather conditions.

Temporary Holding

Shadehouses are used at some locations to acclimatize stock to outdoor conditions. At other locations, seedlings are moved, under favorable weather conditions, directly to holding areas where they are subsequently protected by irrigation from frost, wind, and sunlight. Most growers do not provide for air root-pruning of crops grown outside but place them on a base of coarse crushed rock. Roots penetrate this base, and consequently water loss from the containers is decreased. However, if the roots are left undisturbed too long, root egress from containers becomes significant and stock quality deteriorates. When the container is moved, the active roots below the container are broken, and those left in the container are largely inactive. The pallets used at some locations could be used for air pruning.

Both successful manipulation of the greenhouse environment and suitable weather are required before winter crops are moved outside in spring. Unless a degree of hardiness is achieved, moving seedlings into unpredictable spring weather can be very dangerous and heavy losses have frequently resulted from frost injury.

Overwintering

Stock must by cold hardy, as evidenced by woody stems and well formed buds. Although fertilization with high nitrogen fertilizers is discontinued by late summer, top dressings are needed to complete bud formation, maintain root growth, and prevent chlorosis. If containers are on pallets, they are moved onto the ground before it is frozen to avoid freezing injury to the roots. Edge protection is provided for all stock.

Overwinter protection from sun and wind is necessary to avoid winter drying, particularly in areas with unreliable snowcover. At some nurseries, sheltered openings are cut in a nearby forest. These openings are located so that direct sunlight reaching the crop is minimized. The surrounding trees reduce wind and increase the snowcover over the crop. Fungicides are applied to protect against mold damage, particularly on larger stock or at locations where snow molds have been a problem. Difolitan (captofol) is applied at 1 L per 500 to 1000 m^2. Shadehouses or sealed plastic enclosures may also be used for overwintering. Stock is moved into these structures in the fall, and those covered with plastic are left sealed against moisture loss until spring.

Seasonal and Species Differences in Crop Management

Seasonal

Seedlings grown in late winter often show excessive height with little branching, succulence, and poor root development. Growers attempt to reduce succulence and promote better root development by lowering the greenhouse temperature and relative humidity and by reducing available nitrogen. Currently, supplemental CO_2 is not being used to enhance growth and quality during these limiting conditions of winter.

In summer months, seedlings growing under greenhouse conditions require much water and, because nutrients are readily leached from organic soils, the principal problem is one of supplying adequate moisture while maintaining the necessary levels of soil nutrients.

Species

Black spruce and larch develop readily in the greenhouse but become very succulent under the combination of low light, high soil moisture, abundant nutrients, and elevated temperatures. Problems encountered in growing white spruce crops include the time and uniformity of germination and the prevention of dormancy when stresses are encountered. Jack pine grows rapidly in spring and summer but does not grow well in greenhouses during the low light conditions of winter. It is best grown as a spring-summer crop. Pine species are particularly sensitive to iron chlorosis on the peat or peat-vermiculite medium in combination with the types of fertilizer used in the Maritimes. This chlorosis is readily combatted by an application of chelated iron but not when the soil pH exceeds 6, as has occurred when insulation grades of vermiculite were used or when excessive lime was applied.

CROP SPECIFICATIONS

Stock standards for species raised in containers in the Maritime provinces are still under investigation by most agencies. A survey of specifications in the Maritimes indicates that two criteria are used: 1) the plug must be extractable, and 2) the seedling must be a minimum height--usually 15-25 cm for spruce and larch, and somewhat less for pine and some crops of white spruce. Height is the most commonly used parameter in the Maritimes. Suggested crop specifications for black spruce and jack pine in New Brunswick are given in greater detail elsewhere (Table 4).

A basic problem encountered in many programs is the difficulty in meeting the required crop specifications by the scheduled planting date. Failure to meet specifications generally means that the grower is faced with the dilemma of what to do with a substandard crop. An undersized crop may either be held for further growth or planted. When crops that are too small at the scheduled time of planting are held, the seedlings are often too large for the container and loss of quality is inevitable. Attempting to grow large seedlings in small containers has resulted in quality reduction, diseases of roots or shoots, and inferior shoot:root ratios at time of planting.

Hallett (1980) presented information on the growth of black spruce container crops in the Maritime provinces which suggested the need to develop standard curves for each nursery, species, and cropping method used. This is particularly important for scheduling the planting of winter or summer crops which are still actively growing. Nurserymen usually schedule for size but two other features are important: the plug must be extractable

Table 4. Suggested crop specifications for containerized black spruce and jack pine.

	Total seedling dry weight (mg)	Root-collar diameter (mm)	Height (cm)	Container size (cm^3)	Growing period (wk)
Black spruce					
Hallett[a]	650-850	1.6-2.0	15-20	55-75	16-20
Krause[b]	350-700	1.0-2.0	7.5-15	70	-
Kreiberg[c]	500-800	1.5-2.5	13-25	70	20-24
Jack pine					
Krause[b]	225-550	0.9-1.8	6-12	70	-
Krieberg[c]	400-600	1.0-2.0	10-20	70	-

[a]Hallett, R.D. 1980. Nursery practices for production of black spruce. Dep. Environ., Can. For. Serv., Fredericton, N.B. Tech. Note 13. 7 p.
[b]Krause, H.H. 1978. Appraisal of planting stock. N.B. Dep. Nat. Resour., Internal Rep., 23 p. (prepared by Dep. For. Resour., Univ. New Brunswick.)
[c]Krieberg, N.H. 1981. Personal communication, Fredericton, N.B.

and the shoot must be sufficiently hardy to withstand planting stress. By monitoring crop growth, the nurseryman can alert the planting supervisor if the crop is not ready. (This is better than being told the stock is inferior.)

CONCLUSION

Seedling production has expanded tremendously in the Maritime provinces--from 5 million in 1975 to more than 51 million in 1981. A variety of greenhouses and cultural practices are used to grow this stock, which varies in size and hardiness depending on the season of production and planting.

There are several development needs. Energy conservation techniques are being implemented in heated greenhouses as soon as is practical. Cultural refinements, such as the use of the slow-release fertilizers, are being investigated. The problem of conditioning seedlings for movement from greenhouses during periods of frost, for overwintering, or for outplanting is being studied. An operational method for assessing hardiness would have tremendous potential.

Crop specifications and quality are particularly important in the Maritimes, where an extended planting season is used. Differences in stock quality resulting from season or period of production require the development of crop specifications related to planting site and seasonal conditions. Crops planted in different seasons will require varying degrees of hardiness. Winter crops may be planted in late spring or during the dry, hot conditions of early summer, or they may be held until August when conditions are more moderate. Summer crops may be planted in late summer. Both winter and summer crops may be overwintered for planting as dormant stock in spring, or they may be held for further growth and planted in midsummer. They may even be overwintered a second time and planted as dormant stock in spring.

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APPENDIX

REARING SCHEDULES FOR THE MARITIME PROVINCES

REARING SCHEDULE FOR WINTER CROPS

November to December

Seed Stratification and Greenhouse Sanitation

January (February) [a]

Seeding and Germination

Multiple sowing. Use no seed coating, fertilizers or fungicides. Cover with grit and soak containers to field capacity. Greenhouse temperatures of 24-27°C (D/N) and relative humidity of 80%. Light irrigation as required to prevent drying of seed. Supplemental light to prevent the onset of dormancy (provided as night break).

Late January (late February)

Emergence (0 to 1 wk)

Reduce greenhouse temperature to 18-21°C and relative humidity to less than 80% as soon as possible to prevent etiolation of seedlings and reduce risk of damping-off.

Seed Cap

Irrigate lightly to ensure complete germination and to prevent seed caps from sticking.

Cotyledon (2 to 3 wk)

Thin before significant root branching occurs but after emergence is complete.

Mid-February (mid-March)

Primary Needle (3 wk)

Apply fertilizers at beginning of third week (15 days) after emergence using 10-52-10 plus iron chelate.

March (April)

Active Height (6 to 15 wk)

Apply higher nitrogen fertilizers such as 20-20-20. Apply iron chelate at least once a month. Amend fertilizer formulation according to results of soil analysis.

April (May)

Hardening

Leach solid-wall containers (more difficult with paperpots). Use high day/low night temperatures and dry the soil periodically to induce hardiness by stress. Turn night lighting off. Change fertilizer to high phosphorus (10-52-10) (higher levels of potassium are held in the medium). Shade may become necessary in May; shade only to hold 24°C for spruces, 27°C for pines.

May (June) [b]

Outdoor Growing (15 to 18 wk)

Protect from frost, sun, or windburn. Fertilize with 20-20-20 (extra water and fertilizer required).

Late May to July

Shipping (18 to 21 wk)

Wet soil well before shipment. (Shipment continues over two to five weeks so that 18- to 23-wk-old seedlings are shipped).

REARING SCHEDULE FOR SUMMER CROPS

May (June) [c]

Seeding and Germination

Multiple sowing. Use no seed coatings, fertilizers, or fungicides. Cover with grit and water to field capacity. Greenhouse temperatures of 24-27°C and relative humidity of 80%+. Frequent light irrigation to prevent seed drying and excessive heating of soil surface by sunlight. Night lighting not required.

Late May or June

Emergence (0 to 1 wk)

Reduce greenhouse temperature to 18-21°C and relative humidity to less than 80% as soon as possible to prevent etiolation of seedlings and to reduce risk of damping-off.

Seed Cap

Irrigate lightly to ensure complete germination and to prevent seed caps from sticking (moderate humidity).

Cotyledon (1 to 2 wk)

Thin before significant root branching occurs.

Early June [d]

Primary Needle (3 wk)

Start fertilizing with high phosphorus (10-52-10) plus iron chelate at beginning of third week (15 days) following emergence.

Late June

Active Height (5 wk)

Start use of higher nitrogen fertilizer (20-20-20). Apply iron chelate once a month. Amend fertilizer formula according to results of soil analysis. Maintain temperatures between 18 and 27°C. Attempt 24°C maximum for spruce, and shade only when this temperature is exceeded. Crops may be left in the greenhouse or moved outdoors for the summer.

July

Outdoor Growing (6 wk)

Crops should be moved to raised pallets if they are not to be summer planted. Protect from sun and windburn by irrigating or sheltering. Extra water and fertilizer required.

Mid-August [e]

Shipping

Jack pine crops are shipped starting at 12 weeks.

Outdoor Growing

Crops left in greenhouse now moved out to raised pallets. Protect from sun and windburn. Leach (if no heavy rain) and withhold irrigation periodically to harden. Begin maintenance fertilizer with 10-52-10. Protect from early fall frosts with irrigation.

November

Overwintering

Place on ground to insulate roots. Protect as much as possible from drying winds and sunlight, particularly the edges. If snowmold is a problem, apply protective sprays.

May

Shipping or Growing-On

Ship for planting, or fertilize with 20-20-20.

Late June

Hardening

Leach (if no heavy rains); fertilize at a rate of 10-52-10.

July-August

Shipping

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[a]Months within parentheses indicate that an operation or particular phase may occur at a later date.

[b]Some nurseries move stock to outdoor growing areas at an earlier date than others.

[c]Months within parentheses indicate that a third crop may be started at this time.

[d]If two summer crops are to be produced, this one should be set out as early as possible. It is essential to move the winter crop early, seed the first summer crop, grow to primary needle stage, and move outside. Even the third crop may be moved from the greenhouses in July to avoid severe heat.

[e]Crops can be held in greenhouses until October but extra care is required to ensure cold-hardiness induction before moving outdoors.