To: A.E. McDonald

From: Silviculture Branch
Date: 1988 02 16
File: 955-21

Re: SX 88201Q Day-Night Temperature Regimes

Introduction

Large portions of some crops are culled due to inadequate Root Collar Diameters. This parameter is important because seedlings must be strong enough to withstand the weight of snow and fallen weeds, and because there seems to be a strong correlation between RCD and the ability of the root system to become established after planting. Our understanding of the control of RCD in the nursery is poor, except that tall seedlings usually have the greatest RCD, and that some nutrient treatments have larger RCD's for reasons not understood. In 2-0 spruce crops at Surrey, W. Gates observes that under usual drought stress regimes there is a net carbon loss after midsummer of the second year. Growth including RCD can be sustained if drought stress is not used, but some crops continue height growth and become overly tall.

This trial will attempt to improve RCD and other growth parameters of 1-0 crops based on work by Hallmers and others. Hallmers (1970) found that Engelmann spruce produced the greatest height, RCD and root weight when night temperatures were higher than those in the day (19° day - 23° night). After a five week establishment period at 23° days and 19° nights, and a 24 week treatment period, strong lateral branching, RCD's of 6.5 mm and root weights of 2.2 g were achieved on seedlings less than 20 cm tall (grown in pots). Generally speaking, the higher the day temperatures and the lower the night temperatures, the poorer the growth was, and days of 35° followed by 30° nights were lethal.

Night temperature is a key environmental factor for Engelmann spruce, but in other trials Norway spruce did not show the marked response to night temperatures that Engelmann did, and redwood grew best at lower night temperatures (15°C). Redwood and Engelmann both grew best at day temperatures of 19°C.

In 1972, Brix found that Sitka spruce grew best at a constant 18°, or at 24° days and 18° nights. White spruce was best at 24° days and 18° nights. Night temperatures higher than day temperatures were not tried.

.../2
In 1981, Shepperd followed up on Hellmers work to show the importance of soil temperature. His results for Engelmann were best at day air temperatures of 19°C and soil temperatures of 23°C, and night soil and air temperatures of 23°C. The second best treatment, having shorter and lighter roots, was the same as Hellmers, i.e., 19°C days both soil and air, and 23°C nights.

At present, production greenhouse night temperatures are 18–21°C during germination and early growth, ambient during summer, and ramped down in the fall from 13°C to 8°C to maintenance of 20°C. Considerable gains in growth might be made, particularly of RCD in Se, and in other species like Ow that can not be grown satisfactorily in unheated houses.

Two temperature regimes will be required, one house operated on a typical production temperature regime, and one extrapolated from the experimental regime used by Hellmers. Hellmers growth regime included 8 hours (day temperature) at high light levels in a greenhouse, 8 hours (night temperature) in a growth chamber at 400 ft.c. artificial light, and 8 hours (night temperature) in the growth chamber in the dark.

Experimental Design

All treatments will consist of 4 313A styroblocks and will be duplicated in two greenhouses to be operated at different temperatures.

All treatments will be based on 3:1 peat-vermiculite containing 2 kg/m³ 10 mesh and finer Green Valley dolomite and 750 g/m³ Micromax. Nutrients will be provided with Peters 10–30–20 at 75–100 ppm N during active growth and 50 ppm N as a finisher, plus STEM at 1/2% of fertilizer weight throughout.

Seedlots

The seedlots to be used are:

- Se 8210 (TOA) 82L4 /B3/8210/1.55 - 94% 536 s/g
- Sw 4177 (MEB) 93H11/B3/4177/ .91 - 95% 436 s/g
- Ss 3981 (1100) 93D3 /B3/3981/ .04 - 95% 439 s/g
- Cw 3546 (1070) 92J11/B3/3546/ .86 - 84% 796 s/g
- Fdc 7752 (CSM) 92M10/B3/7752/ .46 - 94% 105 s/g
- Fdl 8149 (2030) 82L12/B7/8149/1.125 - 89% 106 g/s

All seedlots should be double sown and thinned to one seedling per cavity.
Treatments

Both treatments should be subjected to photoperiod extension to 19 hours during active growth as per usual practice. Utilize exterior light sensing equipment to define time to change day-night temperature settings.

Temperature settings are at foliar level. In treatment 2B, maintain night temperature for 6 hours, then allow natural reduction to day setting.

1. Control
   a. Germination and early growth.
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 19°C
   b. Exponential growth period
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 13°C
   c. Ambient phase
      When house can no longer be maintained below 23°C for a substantial portion of the day, remove sidewalls and allow ambient temperatures day and night.
   d. Fall period
      When minimum temperatures at foliar level are below 8°C, replace sidewalls.
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 8°C

2. High Night Temperatures
   a. Germination and early growth
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 19°C
   b. Exponential growth period
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 23°C for first 6 hours, drop to day setting after 6 hours
   c. Fall period - after bud set
      Day temperatures - Heat at 19°C, cool at 23°C
      Night temperatures - Heat at 19°C
Observations Required

Temperature trend logs based on half-hourly readings should be established for soil and foliar level temperatures in both treatments, and for outside temperatures. Furnace operating times should be logged in each house for each phase of growth periods. A record of the changing times of the day-night temperature settings should be made.

All treatments will be processed for morphological description after October 15.

G. Matthews
Agrologist
Silviculture Branch