

ARTIFICIALLY DELAYED SOIL FROST THAWING AFFECTED NORWAY SPRUCE

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Introduction

Soil frost is common in boreal areas. It may affect tree growth at the beginning of growing season. The aim was to study the responses of Norway spruce (*Picea abies* L. Karst) to artificially delayed soil thawing in spring.

Material

- Two treatments in a 32-years old spruce stand in Koli national park, Eastern Finland
 - Control (Ctrl): Natural snow cover and thawing
 - Delayed soil thawing (Frost): Removal of snow in winter, insulation of soil surface in April
- Plot size of the treatments: 20 x 20 m
- Snow depth (Fig. 1), and air and soil temperature (Fig. 2) were monitored
- Measurements: Growth, phenology, physiology and anatomy

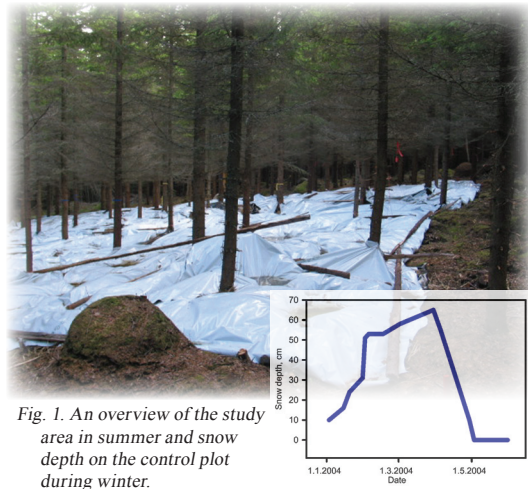


Fig. 1. An overview of the study area in summer and snow depth on the control plot during winter.

Results

- ✓ Bud burst delayed 4 days by delayed soil thawing
- ✓ No difference in the start of diameter growth (Fig. 3A)
- ✓ Dark adapted chlorophyll fluorescence (F_v/F_m) of needles diverged (Fig. 3B)
- ✓ Chlorophyll a and b content of needles diverged (Fig. 3C,D)
- ✓ Extracellular electrical resistance of needles differed (Fig. 3E)
- ✓ Distribution coefficient of relaxation time of needles by impedance spectroscopy diverged (Fig. 3F)
- ✓ Anatomy of needles differed (Table 1, Fig 4). No difference in the ratio of cell numbers to tissue areas.

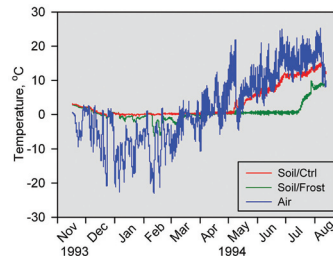


Fig. 2. Air and soil temperature (10 cm depth).

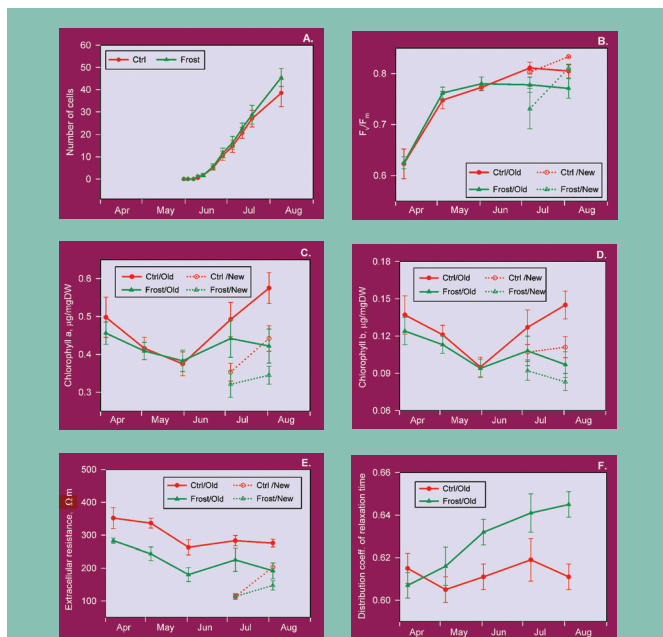


Fig 3. Number of current year tracheids in radial intersects of trunks ($n=4$) (A). Chlorophyll fluorescence F_v/F_m (B), chlorophyll a and b content (C, D), extracellular resistance (E) and distribution coefficient (F) of previous (old) and current (new) year needles ($n=5$). Bars indicate standard errors.

Table 1. Microscopic analysis of current year needles ($n=5$).

Item	Control	Frost
No. of schlerenchyma	15.2	12.0
No. of tracheids	34.5	27.5
No. of sieve cells	42.0	32.0
No. of sieve cells/phloem row	6.4	5.4
No. of rows/phloem	6.6	5.8
Xylem area, μm^2	1716	1391
Central cylinder area, mm^2	.095	.066

Significance of the difference at $P < 0.05$.

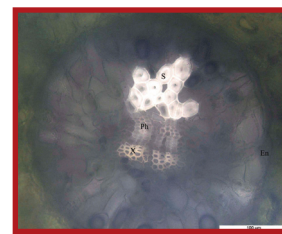


Fig. 4. Fresh cutting of a current-year needle from control treatment. Cross-section shows a vascular cylinder surrounded by endodermis (En), schlerenchyma cells (S), phloem (Ph) and xylem (X).

Conclusions

Symptoms of stress due to delayed soil thawing were observed in trees without clear visual foliage damage. If the delay were repeated in subsequent years, it probably would have implications on yield.