CARDINAL TEMPERATURES FOR GERMINATION OF BALSAM FIR SEED

by
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ABSTRACT

Cardinal temperatures for germination of balsam fir seed were determined by testing germination at different levels of constant temperature from 40F to 105F inclusive. X-ray photography was used to select the seed used from a local Petawawa collection. There was no germination below 45F or above 100F. Twenty-eight days after seeding maximum germination was significantly better at 60F, 65F, and 75F to 85F than at any higher or lower temperature. Significantly poorer germination at 70F was verified but remains unexplained.

Cardinal Temperatures for Germination of Balsam Fir Seed

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INTRODUCTION

This report deals with the germination response to temperature of a local Petawawa provenance of balsam fir (Abies balsamea (L.) Mill.) seed. The objective of the work was to determine cardinal constant temperatures for germination of this species, i.e. the lower cardinal temperature (LCT) below which no germination occurs, the upper cardinal temperature (UCT) above which there is no germination, and the optimum cardinal temperature or temperature range (OCT) at or within which maximum germination occurs. Such information is of interest in programs whose aims are the rapid production of uniform, vigorous seedlings for artificial regeneration, or for research.

MATERIAL AND METHODS

The Tree Seed Unit at the Petawawa Forest Experiment Station supplied a local provenance of balsam fir seed for this experiment. It was collected in 1967 and stored dry in a sealed container at 32F to 36F until

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pre-treated for this experiment in August 1969. No other provenance of balsam fir seed was available.

Before the main experiment began, tests were made of methods of separation of sound from empty seed (e.g. floatation in methyl alcohol and X-ray photography), and of stratification (e.g. cold-soaking in weak acid, and moist stratification). Light requirements for germination were also investigated, and germination at 70F and 75F was better in constant low light intensity than in darkness. Consequently, sound seeds were selected by X-ray photography (dosage: approximately 1.5 roentgens) and were stored, dry, at 35F to 37F. Immediately prior to stratification they were washed for 5 minutes in running distilled water, then surface-sterilized in 1% Javex and spread on blotting paper to dry sufficiently to facilitate surface-seeding by vacuum-plate seeders on saturated Kimpak. Seeded dishes were covered to retard evaporation and stored at 35F to 37F for 5 weeks to provide the recommended moist stratification[2/].

The germination medium was saturated 1/4-inch-thick sterile, bleached Kimpak (cellulose cotton) in disposable, sterile petri dishes. This medium replaced the short grain black germination paper of previous experiments (Fraser 1970a, 1970b) because it had better moisture retention properties and was an equally suitable medium for stratification and germination[2/].

Temperatures were controlled to prescribed levels ± 1F in illuminated, forced-draft, thermostatically controlled constant-temperature

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2/ Personal communication from B.S.P. Wang, P.F.E.S., Chalk River, Ontario

cabinets. The seeds were germinated at a constant low light intensity (approximately 6 foot candles).

Dishes of stratified seeds were removed from storage and assigned, by random methods, to one of 9 positions on glass trays; these trays were in turn assigned, also by random methods, to particular constant-temperature cabinets, and to shelves within each cabinet.

There were 14 temperature treatments at 5F intervals from 40F to 105F inclusive, with 8 dishes of 50 seeds per treatment.

Seeds were tallied as germinates when radicles were plainly visible. Germination was tallied daily for 28 days (International Seed Testing Association, 1959). Cumulative percent germination at 7, 14, and 28 days, transformed to degrees by the arc sine method to normalize the data, were subjected to analyses of variance as completely randomized experiments. Duncan's multiple range test was used to test the significance of means comparisons.

RESULTS AND DISCUSSION

Constant temperature had a significant effect[3/] on germination of balsam fir seeds (Figure 1). The LCTs and UCTs are self-evident. OCT ranges including two or more than two temperatures among which there was no significant difference in germination are shown as shaded plateaus.

3/ $p = 0.01$ throughout this report

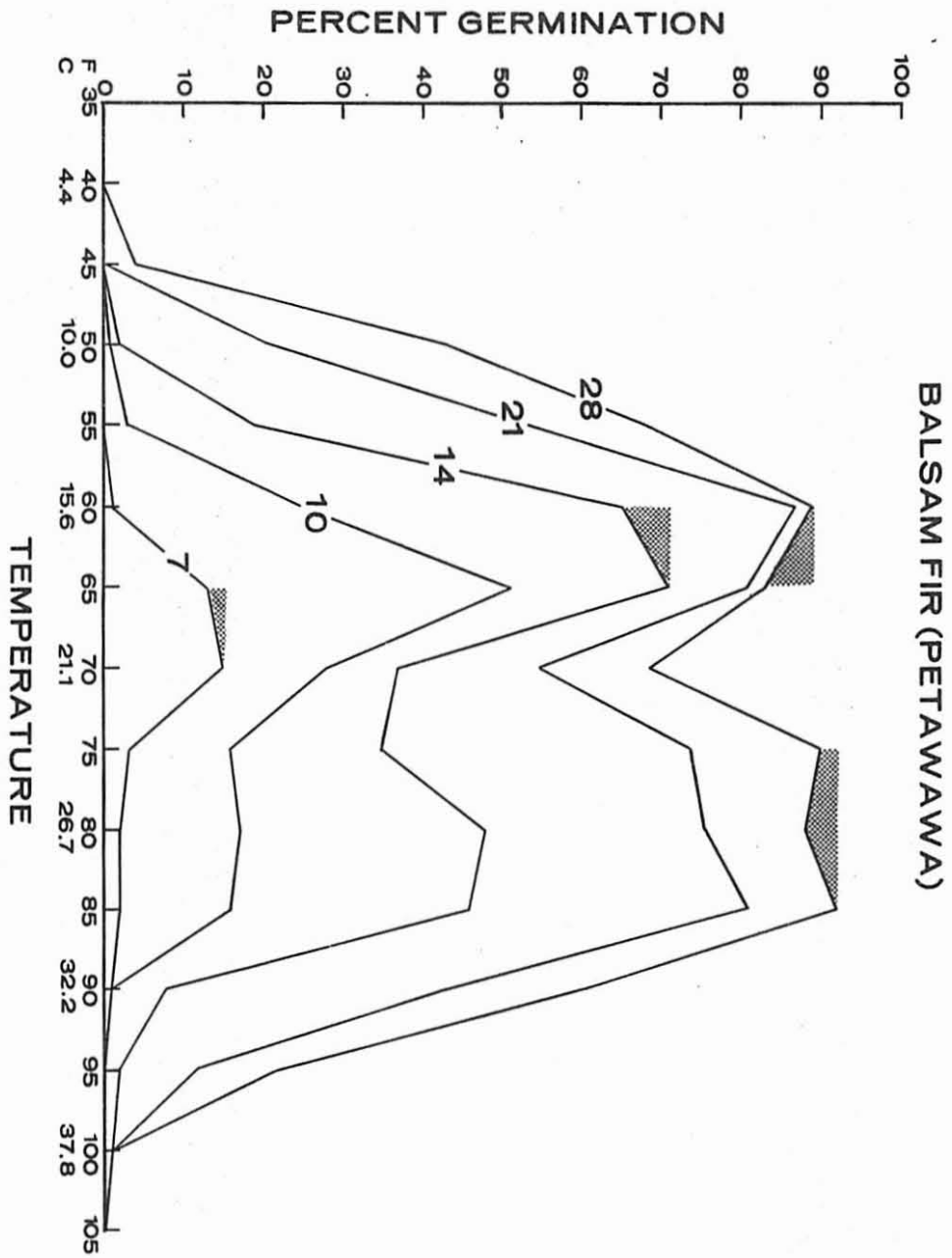

Figure 1. Percent germination of balsam fir seed at various temperatures, 7, 10, 14, 21, and 28 days after seeding. Optimum cardinal temperatures (OCTs), 1, 2, and 4 weeks after seeding are shown as shaded plateaus.

There was no germination below 45F and none above 100F, the LCT and UCT respectively, and germination at both of these temperatures and at 95F by the 28th day were too slow and too poor to warrant further consideration for practical purposes.

With each 5F rise in temperature, from 50F to 65F inclusive, germination occurred progressively sooner and proceeded more rapidly. From 70F to 85F germination began as soon as it did in the 50F to 65F range but proceeded less rapidly. Germination, 28 days after seeding, was significantly worse at 70F than at either 65F or 75F and it was progressively slower and poorer at and above 90F.

Increasing the germination period from 7 to 14 to 28 days lowered the LCT from 60F to 50F to 45F respectively, but only raised the UCT from 90F at 7 days to 100F at 14 days.

The OCTs changed with time from 65F and 70F at 7 days to 60F and 65F at 14 and 28 days, with a second OCT from 75F to 85F at 28 days. Excepting only 70F there was no significant difference in germination from 60F to 85F inclusive. The 70F treatment was repeated in a second temperature-cabinet chosen by random methods, and the results were almost identical.

Although there were well defined cardinal temperatures for germination of balsam fir seed, germination was generally slower and less uniform than in the spruces and pines (Fraser 1970a, 1970b) with the possible exception of white pine, (Pinus strobus L.).

Floatation techniques for selecting sound seeds, and cold soaking in weak acid—both successful pre-treatments for spruce and pine seeds—were completely ineffective in the exploratory balsam fir experiments. Selection

of sound seeds by X-ray photography was successful, and 5-week stratification on moist Kimpak at 35F to 37F resulted in excellent germination, 83% to 92%, at the OCT for 28 days (60F to 85F), excepting the significantly reduced germination at 70F for which no satisfactory explanation is advanced.

CONCLUSIONS

Balsam fir seed from the Petawawa Forest Experiment Station, 46°N, 77°26W, did not germinate below 45F, the lower cardinal temperature, nor above 100F, the upper cardinal temperature. The optimum cardinal temperatures where the best germination occurred were 65F and 70F (7 days), 60F and 65F (14 days), 60F to 85F (28 days), excepting only 70F where, for some unexplained reason, germination was significantly worse than at the next higher and lower temperatures.

ACKNOWLEDGEMENT

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