THE BEDHOUSE: ANOTHER OPTION FOR NURSERYMEN

By

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Abstract - Bedhouses provide a degree of environmental control intermediate between outdoor bare-root beds and greenhouse container facilities. At the Coeur d'Alene nursery in Idaho an experimental bedhouse produced 160 ponderosa pine or 260 western larch per m^2 (15 and 24 per ft^2) that met 1-0 grade standards, whereas no pine and only 85 usable larch per m^2 (8 per ft^2) were produced outdoors.

INTRODUCTION

At present, there are two widely used systems for growing tree seedlings. Bare-root nursery stock is produced in outdoor beds normally for 1 year in the South, 2 years in the Pacific Northwest, and up to 5 years on the Northern Plains. Greenhouse container stock may be produced in 4 months or less, but is usually more expensive than bare-root stock f.o.b. nursery. Intermediate between the two is the bedhouse system developed in Scandinavia and apparently quite successful there (Bergman and Leskinen 1964).

In a bedhouse, bare-root stock is raised under a cover that provides a degree of climate control intermediate between the open field and the fully controlled container greenhouse. The objective is to lengthen the growing season by seeding up to 3 months earlier than outdoors. To do so requires a transparent cover and at least enough heat to maintain minimum growing temperatures. Cooling is usually controlled manually by opening large doors at either end or rolling up the sides part way. The doors or sides could be opened and closed by electric motors controlled by thermostats. When night temperatures are no longer cold, the cover and sometimes the whole bedhouse is removed. Thereafter, the beds are treated the same as any other outdoor beds.

Phipps (1969, 1973) tested bedhouses in Michigan and found they increased germination and seedling growth rates. Weyerhaeuser Corporation experimented with bedhouses in markedly different climates at Aurora and Klamath Falls, Oregon (Cowles 1976). In both places they produced 1-0 seedlings that met grade standards for 2-0 seedlings. Their success was attributed to considerable lengthening of the growing season and maintaining exponential growth of the seedlings. To do so required a minimum temperature of about 10°C (50°F).

Stein[2/] studied growth of seedlings in a bedhouse at the Bend Nursery in Oregon, and succeeded in producing 1-0 stock of several species that met grade standards.

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In 1976, Missoula Equipment Development Center was asked to evaluate bedhouses at U.S. Forest Service nurseries at Coeur d'Alene and Lucky Peak in Idaho. Realizing that it was primarily biological research rather than equipment development, they asked me to conduct the study.

MATERIALS AND METHODS

At the Coeur d'Alene Nursery a 7 x 29 m (22 x 96 foot) tubular steel framed quonset was erected and covered with 2 layers of polyethylene. The doors at each end were made as large as possible for good ventilation and for driving tractors through. Heat was provided by a propane-fired unit heater connected to a perforated polyethylene tube on the ground along one side which distributed warm air evenly throughout the house. Temperature and humidity at ground level were monitored with a hygrothermograph. A recording thermograph measured soil temperature at 1, 12, and 24 cm (1/2, 5, 10 inch) depths. Dial gage thermometers were used to spot check temperatures in different parts of the bedhouse. Soil samples were taken at several locations within the seedbeds.

The bedhouse could hold 4 beds 29 m (96 feet) long, but for the initial test only 2 beds 18 m (60 feet) long were laid out in its center. Similar beds were prepared nearby for the outdoor comparison or control, but were far enough away so they were not affected appreciably by the shadow or wind perturbation of the greenhouse. Both the bedhouse and control were on soil having a similar history with respect to cropping, fertilization, fumigation, and pesticide treatment. Control and bedhouse areas were treated the same with respect to fumigation, fertilization, and pesticide treatment during the study.

Ponderosa pine and western larch were the test species, because they can occasionally, but not reliably, be produced outdoors as 1-0 seedlings.

For each species, two seed sources were used representing as wide a difference in growth rate as possible. The sources were chosen so there would be appropriate planting sites for them in the spring of 1978.

The bedhouse was sown March 3 at a rate calculated to yield 270 pine and 320 larch per m^2 (25 and 30 ft^2). The bedhouse was maintained at or above 21°C (50°F). The doors were opened for cooling whenever the temperature reached 32 C°(90°F). The outdoor beds were sown May 10; the usual time for sowing outdoor beds at Coeur d'Alene.

The cover was removed July 22--more than a month later than planned. This was the first occasion in many weeks that the wind was not blowing. No damage was done, however, because the greenhouse never overheated.

Each month eight seedlings of each seed source were lifted and their height and root collar diameter measured. These seedlings were then pressed and mounted as herbarium specimens.

On November 15 the seedlings were lifted and graded according to nursery standards: 8 cm (3.2 inches) minimum height for both species, 3 mm (0.12 inch) minimum caliper for western larch and 4 mm (0.16 inch) for ponderosa pine. There were no maximum sizes. All seedlings, both shippable and cull, were

counted on each plot. The height and caliper of 10 randomly selected shippable seedlings were measured. From these figures, bed densities of total seedlings produced and seedlings meeting grade were calculated.

RESULTS AND DISCUSSION

Analyses of soil samples taken in the bedhouse and outdoors before planting and after harvest have not been completed, but it is unlikely that they will show major differences. Spring samples were taken only to check the assumption that soil conditions were uniform in all plots. The fall sampling will show the effect, if any, of treatments in this study.

Temperatures within the bedhouse were remarkably uniform, usually $\pm$ 1°C at all test points.

The objective of this experiment was to see if a bedhouse could reduce growing time for ponderosa pine and western hemlock from two seasons to one, and in these terms, the bedhouse was a success.

Table 1 shows the production of total and shippable seedlings of each species and seed source. Of the bedhouse-grown ponderosa pines, more than half met 1-0 grade standards, whereas virtually none of the outdoor grown did. Total seedlings produced in the bedhouse and outdoors were not significantly different.

Nearly half of the western larch in the bedhouse met 1-0 grade standards--three times more trees per unit area than from the outdoor beds. In addition, total number of western larch was about 50% higher in the bedhouse than outdoors. Performance in the bedhouse might have been even better, if bed densities had not been so high because of the unexpected increase in total seedlings produced.

Extrapolating these results to a fully utilized production facility, a 7 x 29 mm (22 x 96 feet) bedhouse with four beds 1.1 m (42 inches) wide could produce 21,000 ponderosa pine or 32,000 western larch as 1-0. If we figure a 5-year write-off for the structure, and that care for a full house would cost the same as for what was grown in the test, then 1-0 larch could be produced for $88 per thousand and pine for $134 per thousand. These costs are substantially higher than the $57 per thousand Coeur d'Alene charges for 2-0 stock, but they are not outrageous for an initial trial.

Figures 1 through 4 show the average growth in height and caliper of each seed source of ponderosa pine and western larch. Each data point is a mean of eight seedlings. The horizontal dotted line is the grading standard. Most seedlings were tall enough to meet grade standards, but failed to reach a large enough caliper.

Except for late summer height growth there was little difference in the performance of the Nezperce (Idaho) and Sitgraves (Arizona) ponderosa pine seed sources.

Height growth of bedhouse-grown ponderosa pine was slow in April, while those grown outdoors showed no such lag at the corresponding age. Bedhouse-grown western larch grew very slowly for three months, which the outdoor grown did not. A

Table 1.--Seed sown and seedlings produced in the bedhouse and the outdoor comparison bed

Species and seed source	BEDHOUSE			OUTDOORS		
	Seed sown	Total seedlings	Shippable seedlings	Seed sown	Total seedlings	Shippable seedlings
	number per m^2 (ft^2)					
Ponderosa pine						
- Nezperce	370 (34)	205 (19)	129 (12)	370 (34)	248 (23)	<1
- Sitgraves	430 (40)	355 (33)	194 (18)	430 (40)	334 (31)	<1
Western larch						
- Kootenai	860 (80)	506 (47)	258 (24)	860 (80)	377 (35)	97 (9)
- Lolo	750 (70)	571 (53)	248 (23)	750 (70)	334 (31)	75 (7)

Figure 1.--Average height of ponderosa pine of two origins in a bedhouse and an outdoor bed at Coeur d'Alene Nursery in 1977.

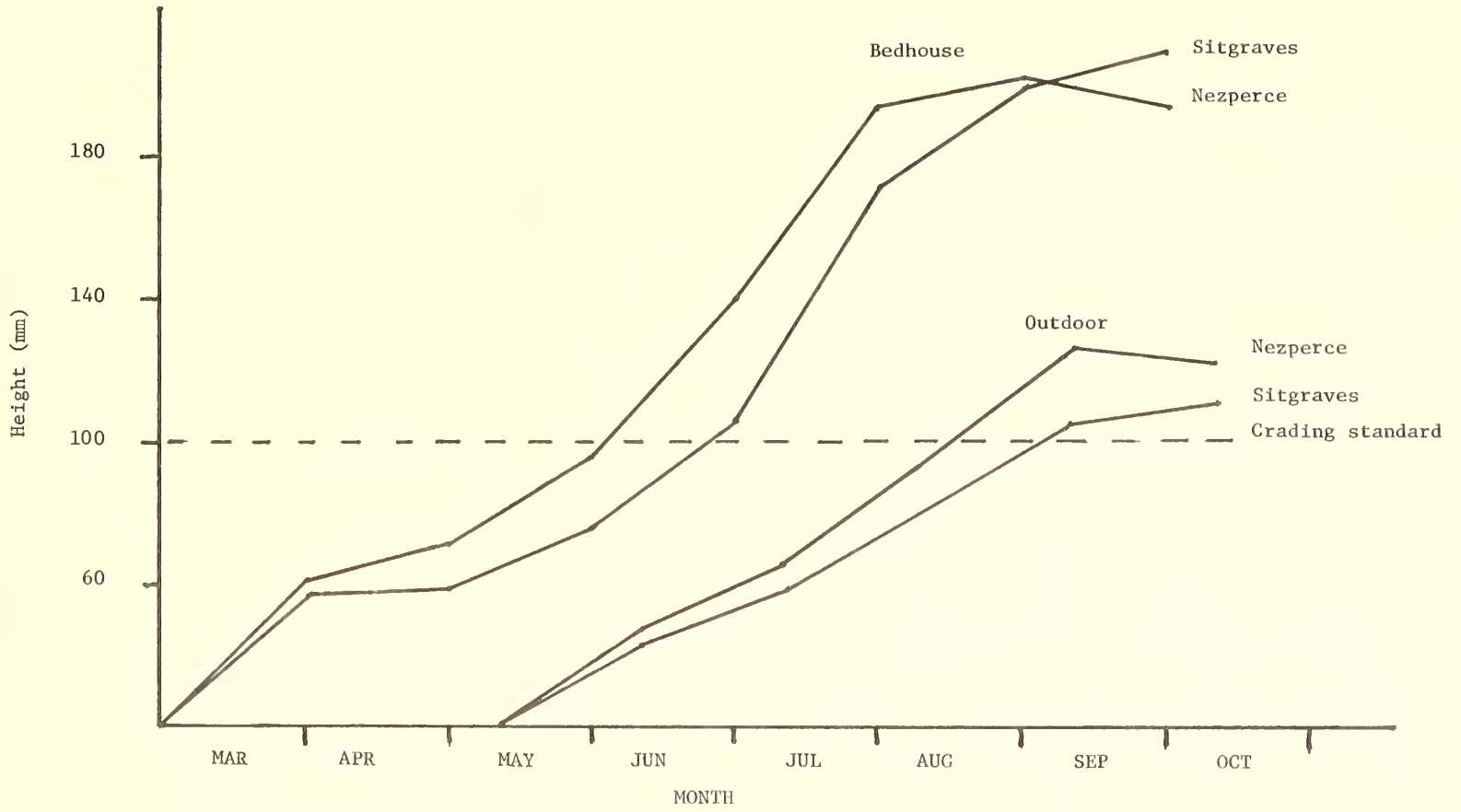
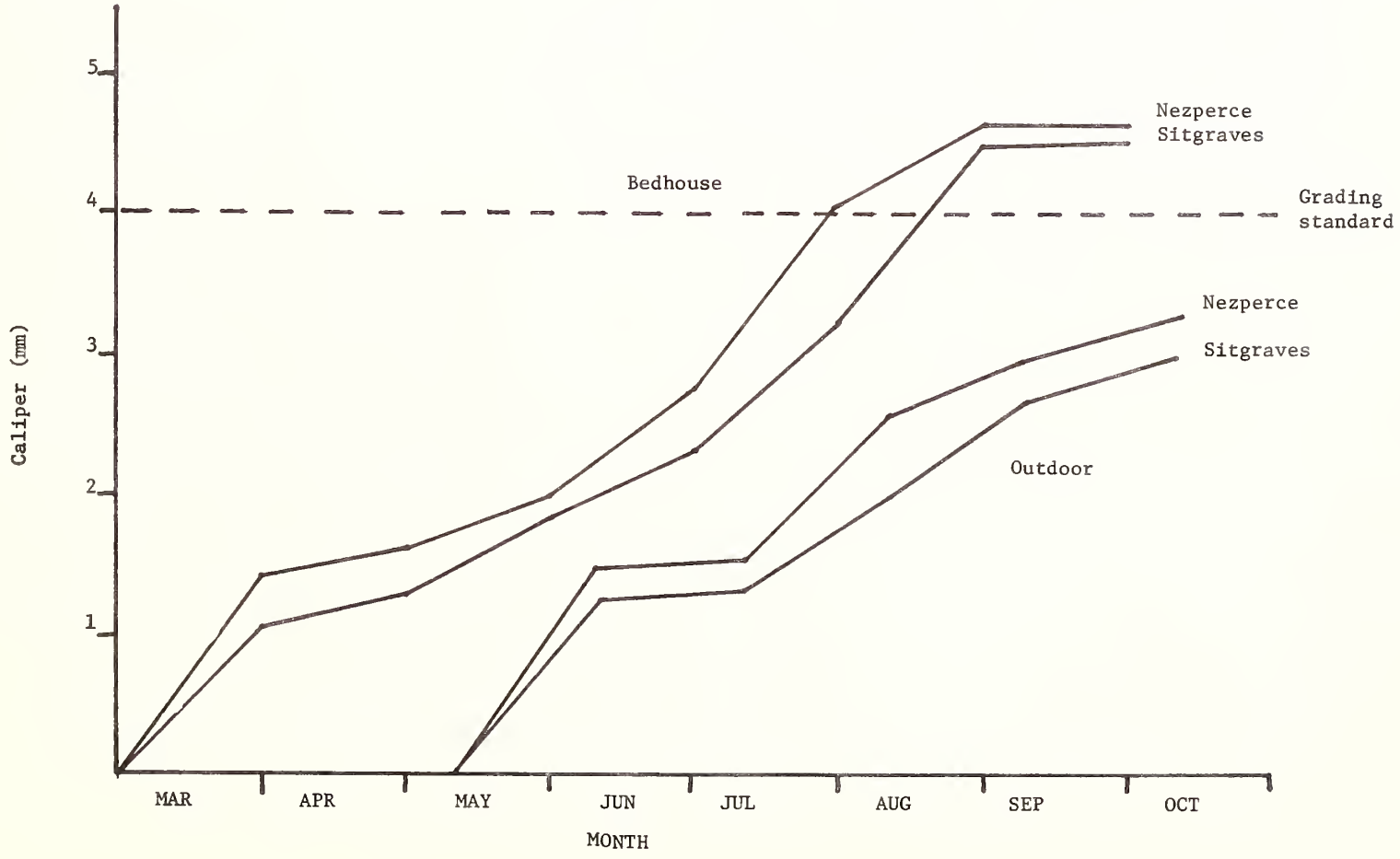


Figure 2.--Average caliper growth of ponderosa pine of a Sitgraves NF and a Nezperce NF origin in a bedhouse and an outdoor bed at Coeur d'Alene Nursery in 1977.



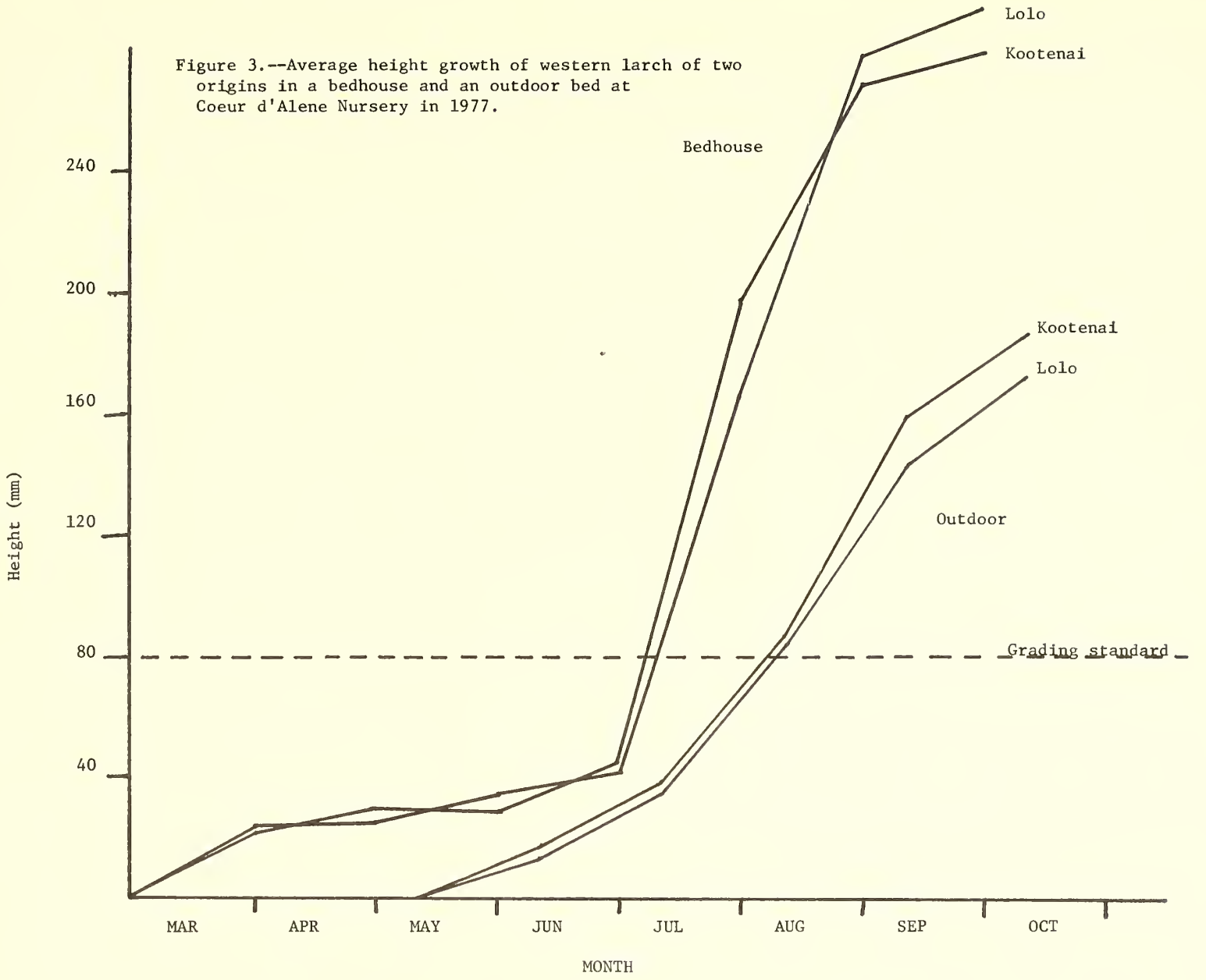
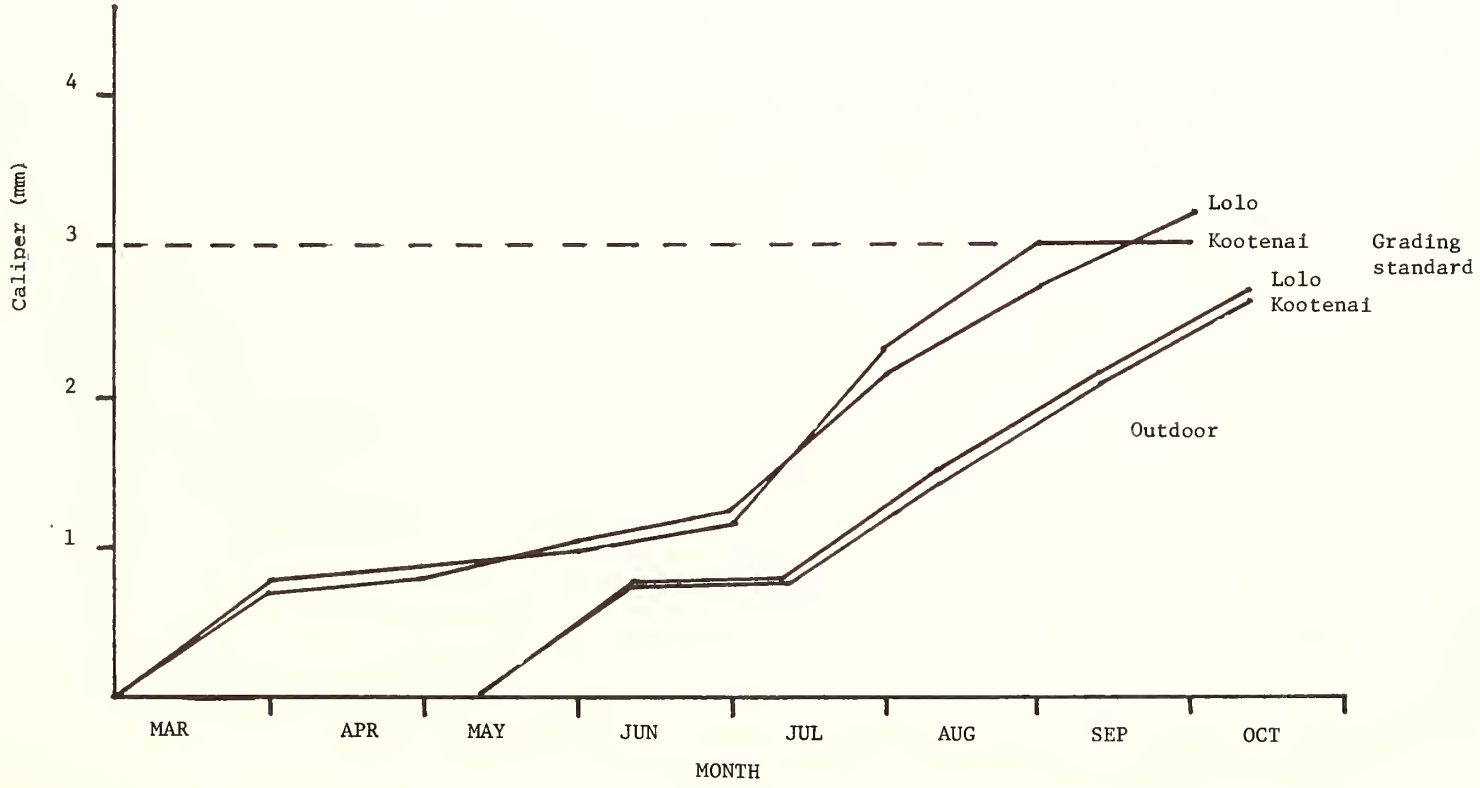


Figure 3.--Average height growth of western larch of two origins in a bedhouse and an outdoor bed at Coeur d'Alene Nursery in 1977.

Figure 4.--Average caliper of western larch of two origins in a bedhouse and an outdoor bed at Coeur d'Alene Nursery in 1977.



similar pattern appeared in caliper growth except that there was also a one-month growth lag in the stock grown outdoors.

The most likely reason for the growth lag is that temperatures were suboptimum. Growth-chamber experiments and considerable greenhouse experience have shown that optimum day and night temperatures for ponderosa pine are between 20° and 25°C (68 and 77°F) (Tinus 1974). Nighttime surface temperatures were optimum only during the germination period (fig. 5). Day temperatures were also suboptimum for the rest of March and much of April and May, but were near optimum in June and July. August was too hot. Figure 6 shows mean day and night temperatures for that portion of the season between planting the outdoor crop and removal of the cover from the bedhouse. If figures 5 and 6 are superimposed, it can be seen that there was little difference in surface air temperatures between the bedhouse and outdoors except for the warmer night temperature in the bedhouse when it was still heated, and warmer day temperatures in May.

We do not have similar temperature effect information for western larch as we do for the ponderosa pine, but for Siberian larch optimum day temperatures are 24-28°C (75-82°F) and optimum night temperatures are 16-26°C (60-78°F) (Tinus and McDonald 1978). If we assume the two larches behave similarly (a hazardous assumption), then night temperatures were almost never warm enough except during the germination period. Except for a few warm days in April, optimum day temperatures were not reached until June. August day temperatures may have been more appropriate for larch than for pine.

The implication is that if warmer temperatures were maintained after germination, there would be no growth lag, and the same size seedling could be grown in a shorter time.

This year, Coeur d'Alene and Lucky Peak nurseries each have two bedhouses, and tests in progress will build on what we learned last year. One bedhouse each was seeded March 1, and temperature was maintained at 21° C (70°F) only during germination and then reduced to 10°C (50°F) just as it was last year. However, lights were added in this house to lengthen the photoperiod to the equivalent of a 24-hour day. The other bedhouse at each nursery was seeded April 1 and maintained at 21°C (70°F) minimum temperature until the heat was turned off at the end of May.

Coeur d'Alene is at 48°N, and all seed sources except the Sitgraves ponderosa pine are from similarly high latitudes. These seed sources can be expected to go dormant under the normal photoperiod prevailing in Coeur d'Alene in March and April, although germinants from seed sown March 2 may not be mature enough to set bud before long days arrive. Starting a month later (April 1) should make quite a difference in seedling response, but maintaining the minimum temperature at 21°C (70°F) for two months will be expensive even though the cold month of March is avoided. If an extended photoperiod can substitute for warm night temperature, it will undoubtedly be a cheaper cultural practice. We will not know until December what the results of our 1978 tests are.

What does the bedhouse offer nurserymen in the Southeast, where even 1-0 seedlings can grow too large? Bedhouses will certainly not replace the outdoor nursery, but there are special situations where they may prove useful.

Figure 5.--Mean day and night surface air temperatures in the bedhouse at Coeur d'Alene Nursery 1977.

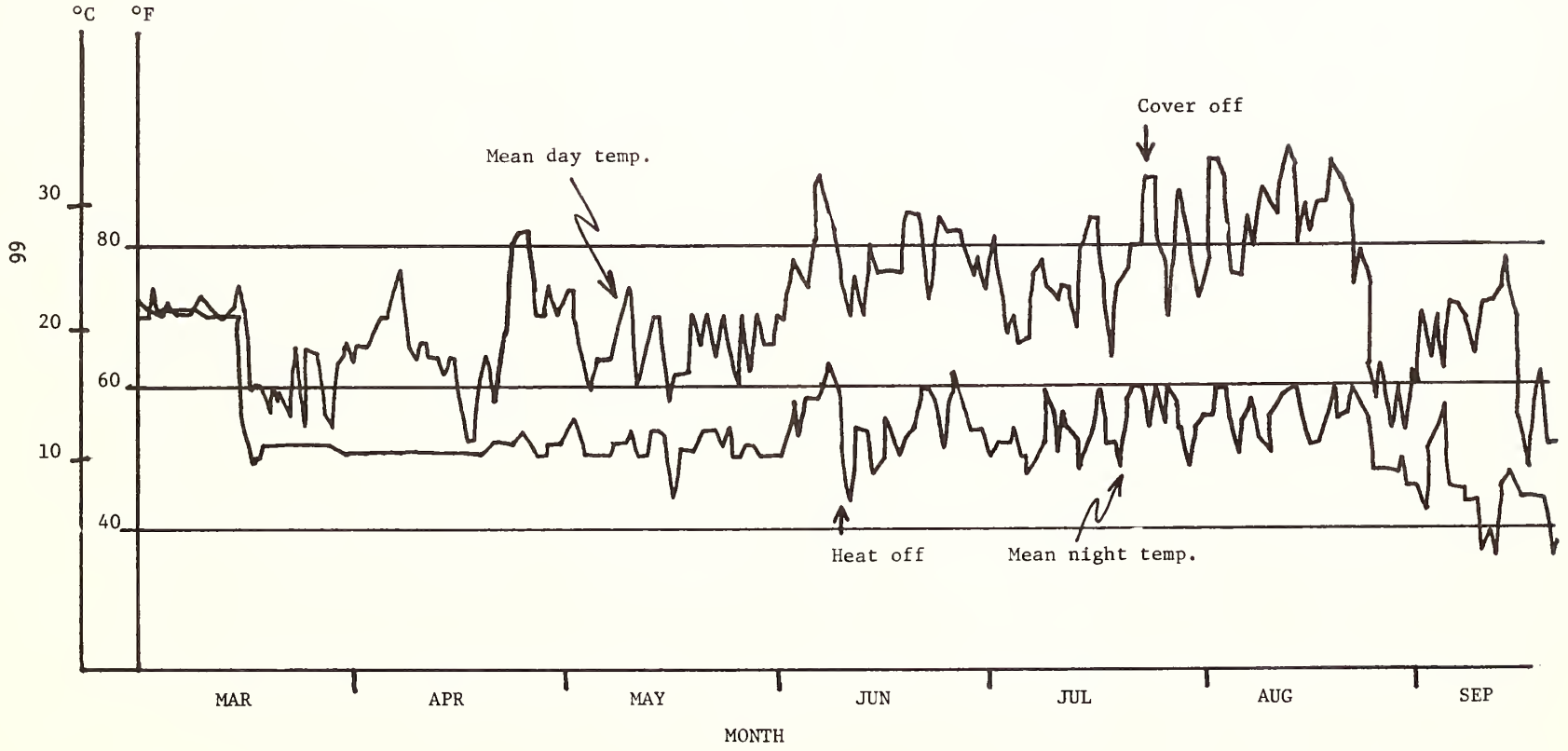
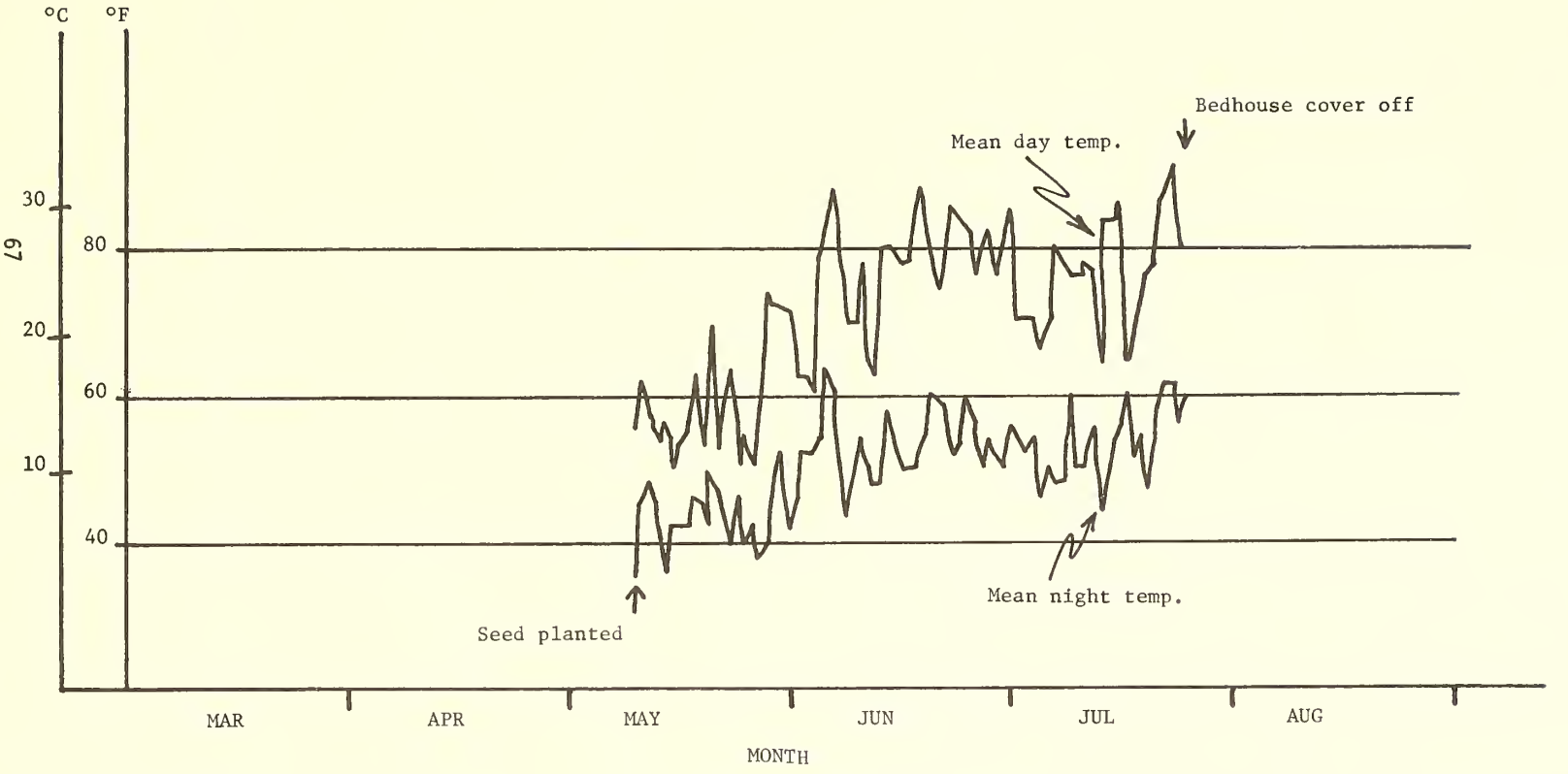


Figure 6.--Mean day and night surface air temperatures in the outdoor comparison beds.



North Carolina produces container-grown Fraser fir which is then transplanted outdoors and eventually sold as bare-root stock.[3/] Perhaps a bedhouse would permit rapid and direct production of the desired bare-root seedling at less cost.

Perhaps eastern white pine could be produced in one year in a bedhouse instead of the two years it takes outdoors. Perhaps shortleaf and Virginia pine could be raised to a larger size in a bedhouse, which ought to improve field survival.

I am sure each of you can think of other cases where a bedhouse might be useful. Here, I have tried to introduce you a new tool and show how controlled environment research is being used to assess the value of that tool and improve it for your use.

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