

TEMPERATURE AND ITS EFFECT ON THE GERMINATION AND INITIAL GROWTH OF KAURI (*AGATHIS AUSTRALIS*)

I. L. BARTON

Forestry Section, Auckland Regional Authority, Hunua

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ABSTRACT

Kauri seed will germinate between 10.5° and 36°C. However, for raising seedlings, germination and initial growth is adequate only between 19.5° and 27.5°C. The optimum temperature is at, or close to, 25.0°C.

INTRODUCTION

Mirams (1951), using seed from Waipoua Forest and the Waitakere Ranges, obtained germination of kauri (*Agathis australis* Salisb.) at five temperature regimes between 12°C and 36°C. Total germination and germination rate were best between 24°C and 30°C. He concluded that the optimum temperature for germination was near 24°C. He also discovered that kauri would germinate at 12°C but took 40 days to do so.

Bielecki (1959), using seed that was probably from Waipoua forest, discovered that the optimum growth temperature for 3- to 6-month old seedlings was between 23°C and 26°C. However he grew seedlings only at 20°C, 25°C and 30°C and the temperature variation around these means was as much as $\pm 3^\circ\text{C}$. Because of this he was unable to be certain of the optimum germination temperature and was unable to define the full range over which germination and growth was possible.

A temperature gradient table that enabled temperatures between 10.5°C and 40.5°C to be maintained with little variation was used to investigate growth and germination in more detail.

METHODS

The temperature gradient table, designed and set up in the Botany Department of the University of Auckland, was located in a windowless, and usually unlighted, internal room.

In order to minimise genetic variation seed for this experiment was taken from one tree on the southern edge of the Hunua Ranges. The proportion of sound seed was close to the average for seed trees in the area in 1977, as was the Germination Value (Czabator, 1962). Ten viable kauri seeds were placed on germination paper in

each of 30 Petrie dishes and the dishes placed in 14 pairs on the gradient table. The fifteenth pair were placed in a cold chamber where the mean temperature was 6.5°C (range $5.5^{\circ}\text{--}9.5^{\circ}\text{C}$).

The temperatures for each position on the gradient table were taken daily with mercury thermometers, the bulbs of which were immersed in containers of water on the table, and with a thermister probe. The mean temperature for each position on the gradient table was determined from all the readings of the two measurement methods. Temperature ranges at each position were between 2.5°C and 6°C at different times during the experiment. However the Standard Deviation was never more than 1.5°C . Watering of the dishes was done as required, more frequently at the top end of the heat gradient. Twice daily for the first four days, and then daily until the fourteenth day when the experiment was terminated, the following information was recorded.

- (i) Temperatures.
- (ii) The number of seed that had germinated (i.e. radicle clearly emerging from the seed).
- (iii) Length of radicle and hypocotyl. The difference was ascertained by the colour variation at the root collar.
- (iv) The number of testas shed.

During the 14-day period, the "shoot" portion of the seedling was the hypocotyl, i.e. no true shoots or leaves had developed. Similarly the "root" portion of the seedling was the radicle. Fungus attack was a problem where temperatures were above about 25°C . The developing fungi, the spores of which were on the testa, appeared to attack the emerging radicle. Application of a weak fungicide prevented more than one or two losses.

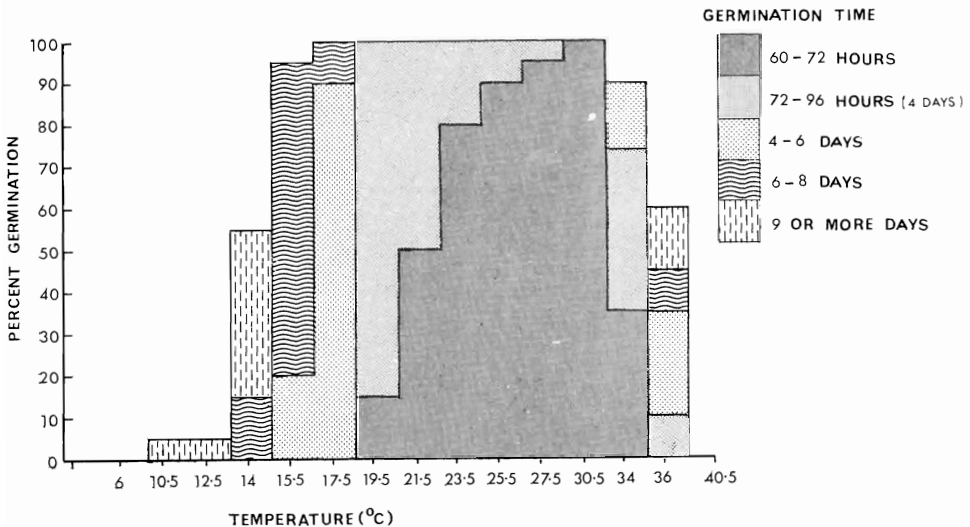


FIG. 1—Germination time at different temperatures.

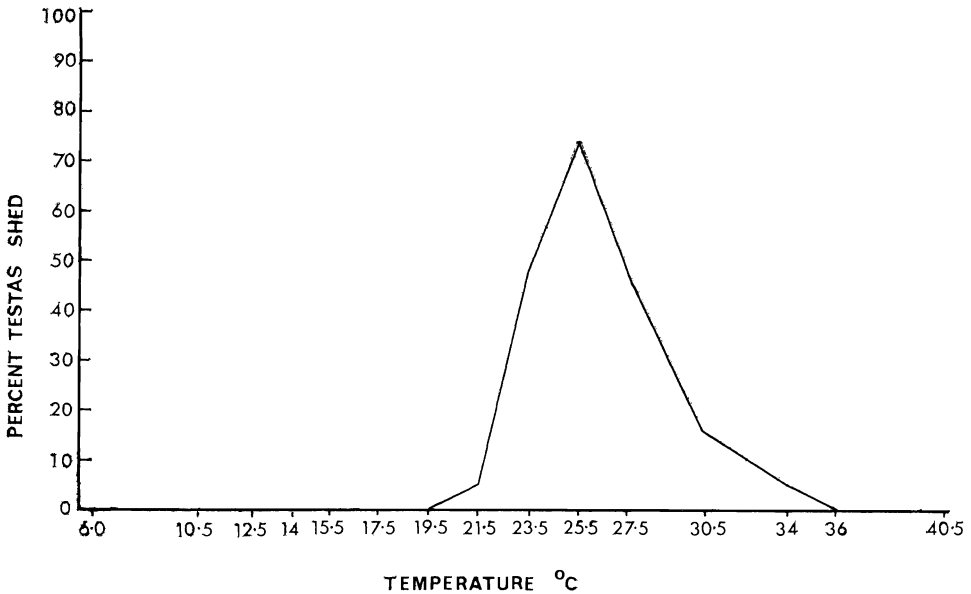


FIG. 2—Testas shed at 14 days.

RESULTS AND DISCUSSION

Germination and Testa Shedding

Germination did not occur below 10.5°C or above 36°C, and was poor below 15.5°C and above 34°C (Fig. 1).

During the 14-day period no testas were shed below 21.5°C or above 34°C and most were shed at 25.5°C (Fig. 2). Other records, kept for periods longer than 14 days (ARA Nursery, Hunua) indicate that testas are shed more slowly at higher and lower temperatures.

Growth

Growth was optimum at 25.5°C and reasonable between 19.5°C and 27.5°C. At higher and lower temperatures the growth rate falls off rapidly (Figs. 3 & 4). Radicle growth occurs at both lower and higher temperatures than hypocotyl growth, but is greater at lower temperatures. Both radicle and hypocotyl grow better at 25.5°C. Radicle growth is optimum between 17.5° and 27.5°C and hypocotyl growth between 19.5°C and 34°C. Thus the hypocotyl/radicle ratio at 14 days, which in the temperature range 19.5°-27.5°C is close to 1.0, becomes markedly higher at higher temperatures.

The optimum range for each parameter studied thus fell between 19.5°C and 27.5°C, except for the shedding of testas which covered a narrower range, and germination time and hypocotyl growth which extended to 30.5°C. Between 15.5°C and 19.5°C germination and growth was adequate but much slower. Over 27.5°C germination and growth can occur but such temperatures are probably seldom reached in nature. If they were reached on the forest floor it is likely that the seedling would be destroyed by fungi.

Mirams (1951) concluded that the optimum temperature for kauri germination was between 24°C and 30°C and was probably near 24°C. Bielecki (1959) considered the optimum to be between 23°C and 26°C; although he used seed from two different

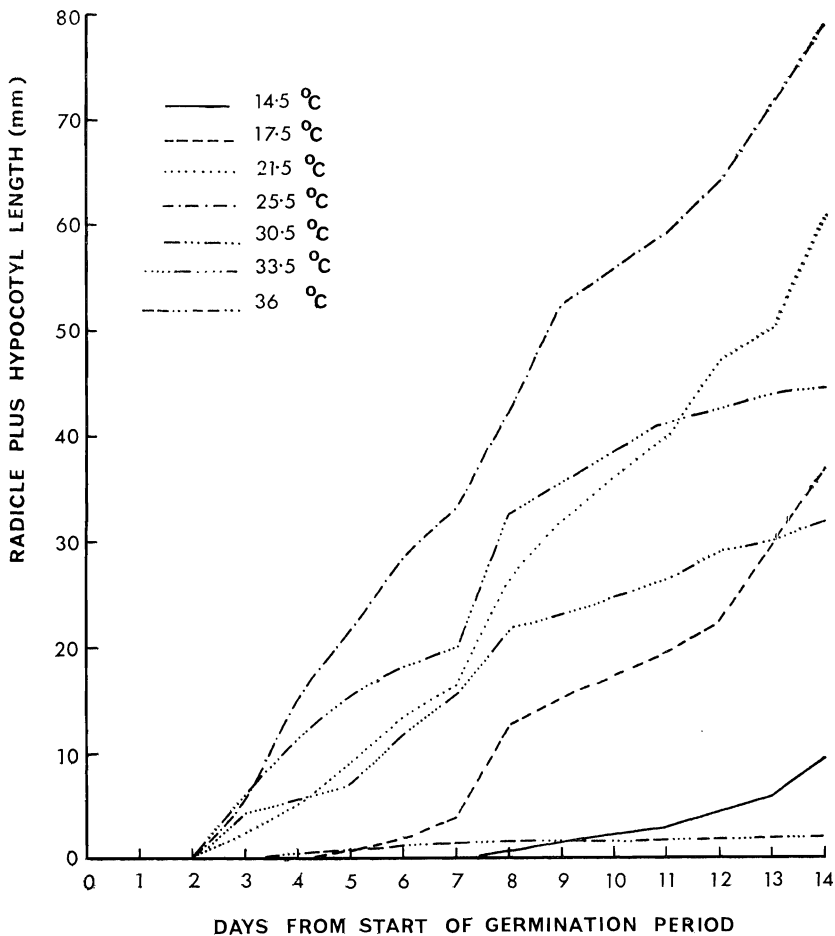


FIG. 3—Total growth at different temperatures.

trees which, in his opinion, behaved differently. Because of this he concluded that a well defined optimum probably did not exist. However, a comparison of these data with that from the present experiment, tends to support the results of the present work. Thus whatever the seed source the optimum temperature for germination and initial growth will be in the vicinity of 25°C.

Mirams (1951) found that germination did occur at temperatures as low as 12°C but that the germination period was 40 days. It is thus possible that kauri can germinate at temperatures at or below the lowest of this experiment (10.5°C) but that the germination period will be considerably longer than 14 days.

As the temperatures in this experiment were almost constant, the effects of diurnal variation are unknown. Such variation would probably not alter the optimum temperature but could extend the lower temperature range over which reasonable germination and growth can occur.

The experiment indicates that, where glass house facilities are available, it should

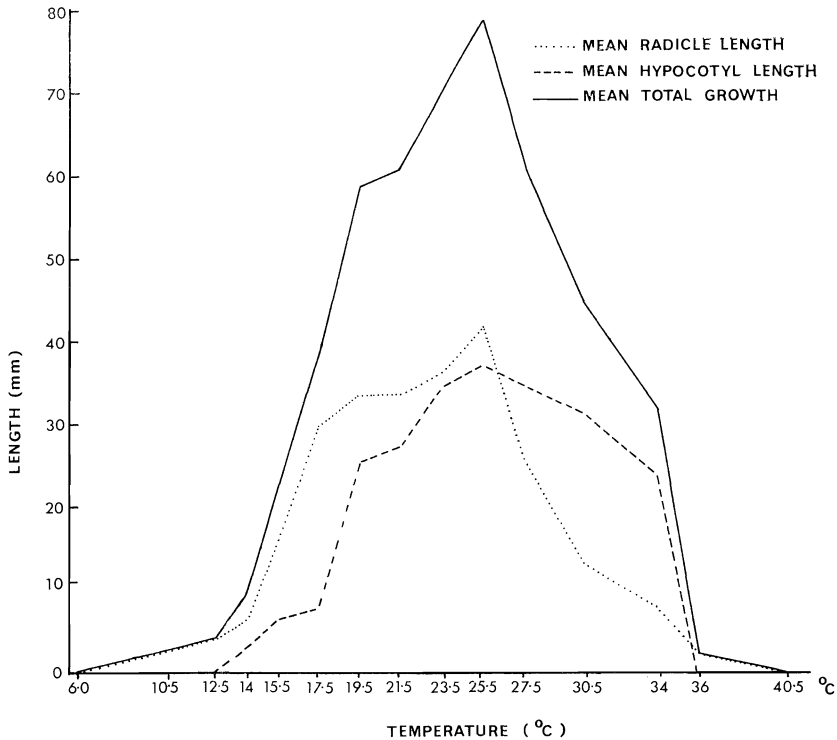


FIG. 4—Relative growth of hypocotyl and radicle.

be possible to germinate and grow kauri seedlings at the fastest possible rate by adjusting the mean daily temperature, within the house, to as close as possible to 25.5°C.

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