Seasonal growth characteristics of red beech, Corsican pine, ponderosa pine, radiata pine, and Douglas fir nursery seedlings

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ABSTRACT

Weekly measurements of shoot extension in red beech (Nothofagus fusca), Corsican pine (Pinus nigra), ponderosa pine (P. ponderosa), radiata pine (P. radiata), and Douglas fir (Pseudotsuga menziesii) seedlings were compared for the 1984-85 growing season at the Forest Research Institute nursery at Rangiora, Canterbury. The period of rapid shoot extension and time of bud set varied markedly between the five species. More than 70% of total seasonal height growth of Corsican pine and ponderosa pine was made during the months of October and November compared with the longer rapid growth period (3-5.5 months) for the other species. The rapid shoot growth phase of red beech, radiata pine, and Douglas fir seedlings followed the pattern of mean monthly air temperature, but shoot growth and bud set of Corsican pine and ponderosa pine was less dependent on temperature. The results of this study suggest that undercutting and wrenching need to be co-ordinated with the period of rapid shoot growth.

Little information is available on the seasonal growth characteristics of tree seedlings grown under typical nursery regimes in New Zealand. Such information is useful to nursery managers because it can provide a basis for planning nursery regimes and manipulating seedling growth to meet desired seedling grade and quality specifications. For example, seedling height can be controlled by undercutting or wrenching during periods of rapid shoot extension (van Dorsser and Rook 1972), or sowing dates can be adjusted to take advantage of periods of optimumn seedling growth.

SPECIES AND METHODS

Seedlings of four North American conifers (Corsican pine, ponderosa pine, radiata pine, Douglas fir) and one New Zealand hardwood (red beech) (Table 1) were grown at the Forest Research Institute nursery, Rangiora, a sheltered flat site (40 m a.s.l.) with fertile Wakanui silt loam soils.

The accepted age for radiata pine planting stock in New Zealand is one-year-old seedlings and for the other four species it is two-year-old seedlings (i.e. seed was sown one year before the study started). Seed was sown in raised nursery beds, and seedlings were thinned to a spacing of 10 x 14 cm. A routine cultural regime was maintained throughout the study period. This included:

(i) an undercut at a depth of 8 cm in early September, before growth initiation, for all species except radiata pine;
(ii) a wrenching during December for Douglas fir seedlings;
(iii) an undercut for radiata pine seedlings during March;
(iv) a wrenching for all species except radiata pine during March; and
(v) a wrenching for all species during April and May.

TABLE 1. Species, year seed collected, and origin locality

Red beech	1982	Maruia Valley
Corsican pine	1983	Balmoral
Ponderosa pine	1983	Tara Hills
Radiata pine	1984	Gwavas Seed Orchard
Douglas fir	1979	Ashley Forest

The terminal shoots of 20 randomly selected uniform seedlings of each species were marked with a white paint dot to establish a measurement reference point. The distance from this point to the tip of the terminal bud or needle cluster was measured to the nearest millimetre each week for the two-year-old seedlings. Radiata pine seedlings were measured from the root collar to the tip of the terminal needle cluster. The terminal shoots of three red beech seedlings were damaged during the study, and measurement of these seedlings was discontinued.

Mean monthly air temperatures were available from a permanent meteorological station (H 32352) within 200 m of the study area. Rainfall was not considered as seedlings were irrigated on a regular basis to maintain optimum soil moisture conditions.

RESULTS

Growth Initiation

Buds of Corsican pine and ponderosa pine seedlings began elongation in late September, two weeks earlier than those of Douglas fir and red beech (Fig. 1.). Radiata pine sown in October was first measured in late November, approximately two weeks after seedling emergence.

Rapid Shoot Growth

The period of rapid shoot growth (when weekly shoot growth exceeded 3% of total season's growth) varied considerably between the five species (Fig. 1). Rapid shoot extension in Corsican and ponderosa pine began soon after initial bud elongation and continued until bud set in late November when 70% of the total seasonal growth had been achieved. In Douglas fir and red beech, rapid shoot growth extended over three and 5.5 months respectively, starting in late October. In radiata pine, rapid shoot growth extended from early December to mid-April.

Bud Set

Corsican and ponderosa pine formed terminal buds during the last week of November, but irregular bud elongation continued until final bud set in April (Fig. 1). In contrast, Douglas fir (apart from a temporary bud set after wrenching in early December) and red beech continued shoot growth until terminal bud set in March and May respectively. Radiata pine

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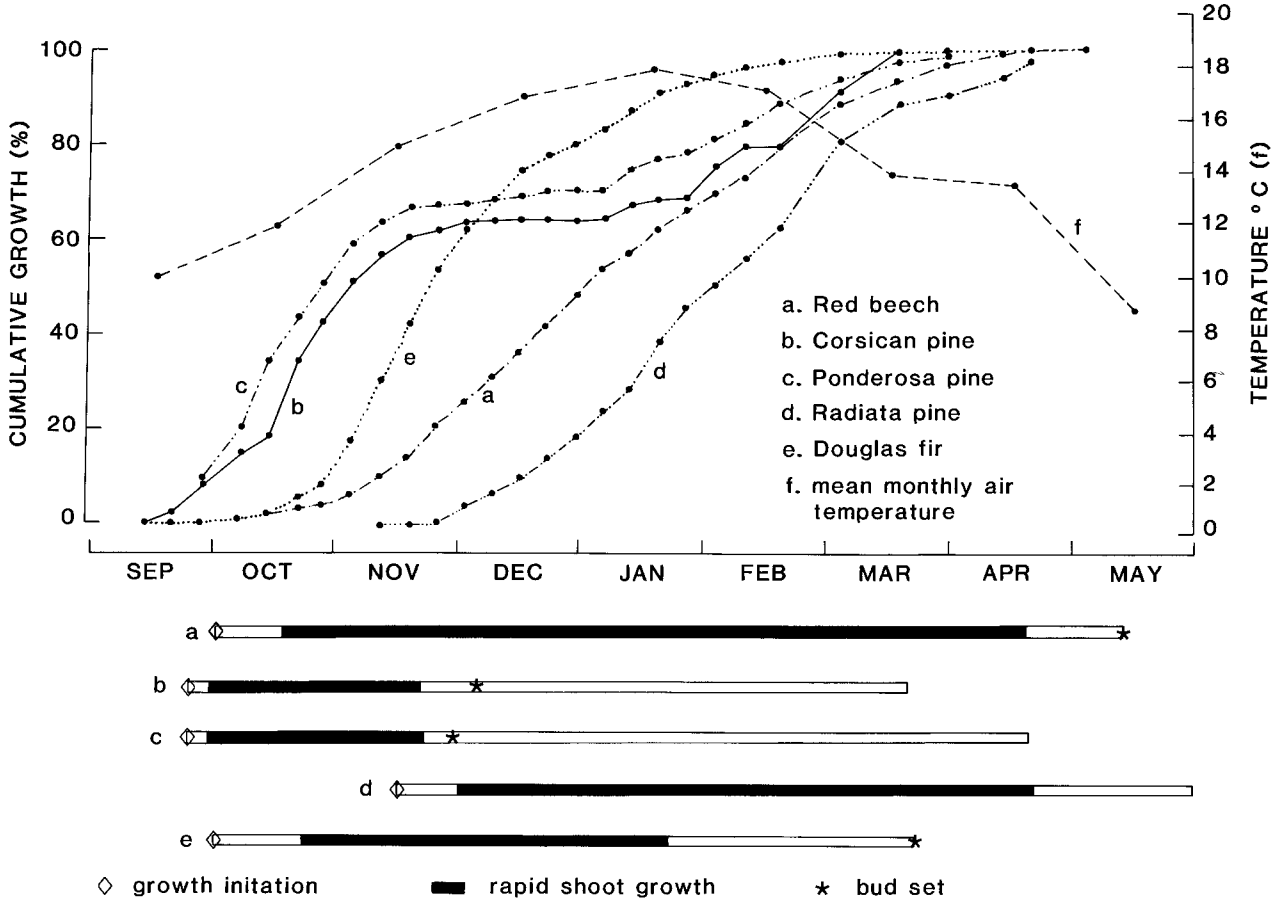

FIGURE 1 Cumulative seasonal growth patterns of red beech, Corsican pine, ponderosa pine, radiata pine, and Douglas fir seedlings and mean monthly temperature values for the Rangiora nursery site. The timing of the different growth phases is also shown.

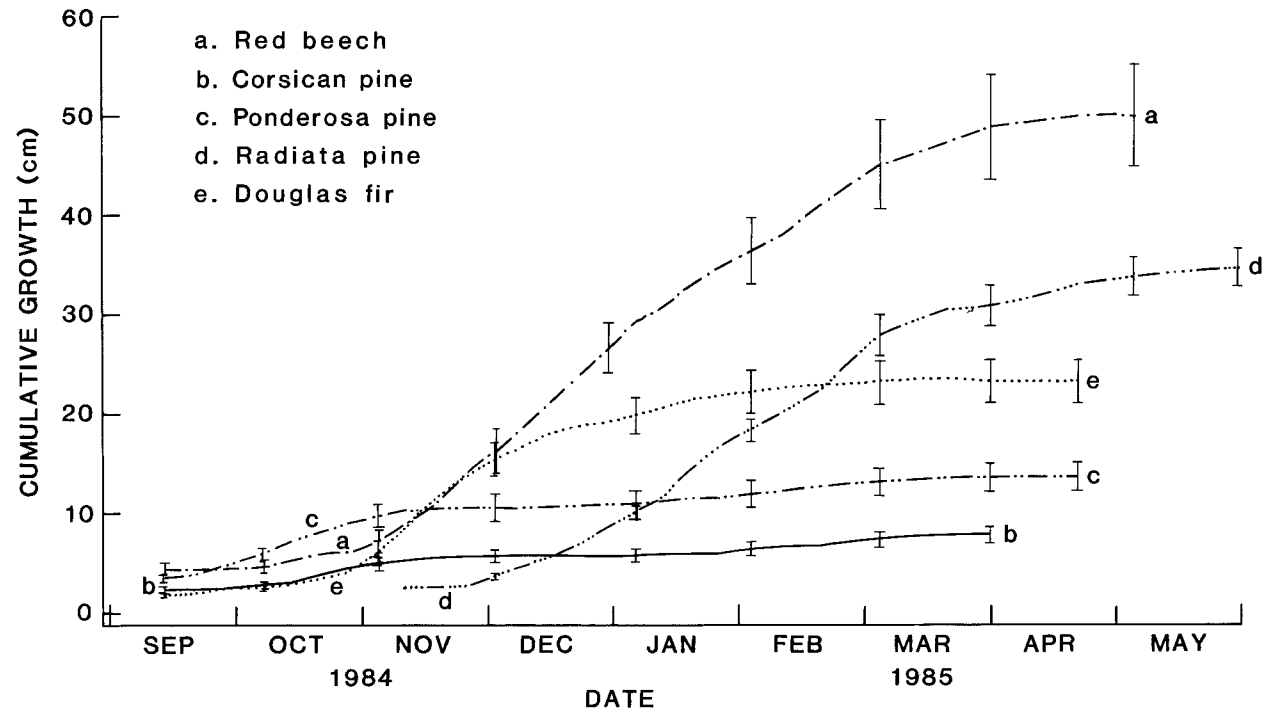

FIGURE 2 Total height growth and variability (95% Confidence Limits) in red beech, Corsican pine, ponderosa pine, radiata pine and Douglas fir seedlings.

seedlings in New Zealand do not set a true dormant bud in their first season's growth (van Dorsser and Rook 1972).

Total Growth and Variability Within Species

Total seasonal growth of the measured terminal shoots was 5.9 cm for Corsican pine, 10.0 cm for ponderosa pine, 20.9 cm for Douglas fir, 32.2 cm for radiata pine, and 46.0 cm for red beech (Fig.2). The coefficient of variation between individual seedlings within species was no greater than 10%.

Temperature/Growth Relationship

Timing of the rapid shoot growth period is influenced by various factors, particularly degree-hour heat sums and solar radiation (Boyer 1970), soil temperature and the previous season's bud formation, but air temperature only was examined in this study.

The mean monthly air temperatures (Fig. 1) for September-May 1984/85 were 0.5°C warmer than the 15-year monthly means for 1965-80. Growth was initiated for all two-year-old seedlings when the mean monthly air temperature exceeded about 10°C in September. The period of rapid shoot growth of Corsican pine and ponderosa pine seedlings occurred early in the season and did not follow the pattern of increasing air temperature, as 70% of seasonal growth was completed six-eight weeks before January, the month with the highest mean air temperature. In contrast, rapid shoot growth in Douglas fir, and particularly red beech and radiata pine seedlings, more closely followed the pattern of mean monthly air temperature.

DISCUSSION

The short rapid growth period of Corsican and ponderosa pine seedlings immediately after growth initiation described in this study has also been reported for pine species in the Northern Hemisphere (e.g. Boyer 1970) and in other New Zealand studies (Benecke *et al.* 1978). However, it is the markedly different patterns of rapid growth between the five species studied that is of interest. The timing of undercutting or wrenching needs to be co-ordinated with the rapid growth phase. This is particularly important for Douglas fir, red beech, and radiata pine seedlings, not only to condition seedlings before transplanting (van Dorsser 1981), but also to control height growth and to purpose-grow seedlings of an acceptable size for packaging and field planting. If necessary, the height growth of Corsican and ponderosa pine seedlings may be altered significantly by wrenching seedlings during their short period of rapid growth. Shoot length may also be controlled by topping, but early trials with radiata pine showed that topping alone was ineffective in conditioning planting stock for transplanting. Undercutting and wrenching too early in the season can result in seedlings that are too small, and if it is delayed seedlings can be too large and not fully conditioned. The seasonal growth patterns of nursery seedlings vary considerably between species, different seasons, and climatic regions in New Zealand. Knowledge of these growth patterns for individual nurseries should improve nursery management.

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It's been a nervous summer for the new rural fire authorities formed in the wake of Government's public service reorganization. Without the expertise and manpower of the Forest Service, quick response and co-operation between authorities has been the order of the day. Extreme fire hazards during late January to early February have been accompanied by a spate of fires, some of which have been potentially serious. None, however, overwhelmed the new organizations, eager to prove that they are capable of matching the past performance of the Forest Service.