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Short Communication

First Report on Precocious Flowering in 5-month-old *Peumus boldus* Mol. Seedlings

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ABSTRACT

Whereas *Peumus boldus* Mol. rarely flowers in its native habitat until at least 4 years old, in this article, we report the precocious flowering of 5-month-old *P. boldus* seedlings and provide possible explanations for this phenomenon. We cultivated 3000 seedlings during 6 months under nursery conditions, and three plants representing three different mother trees from a single stand flowered at 5 months since sowing.

Keywords: Adaptations, climate change, Mediterranean vegetation, precocity

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Introduction

Flowering represents phase change from juvenility to maturity (Zimmerman et al., 1985); thus, all plants originated through sexual reproduction must go through a juvenile period before acquiring the capacity for flowering. The duration of this period varies between species and ranges from 3 years for *Pinus greggii* Engelm. ex Parl. (Donahue & López-Upton, 1995), 10–15 years in species of temperate zones (Owens et al., 1991), to 30–40 years for *Pinus lambertiana* Douglas and *Fagus sylvatica* L. (Meilan, 1997). However, the first flowering usually occurs earlier than the average age and this event is called precocity or precocious flowering. Precocious flowering seedlings can provide food for fruit-consuming fauna sooner than natural regeneration and can be used in crosses to produce precocious flowering offspring.

Peumus boldus Mol. (boldo) of Monimiaceae is an endemic and dioecious tree, typical of the Mediterranean-type ecosystems whose range of distribution spans over 10° latitude in the Mediterranean-type climate area of Chile (ca. 1200 km) (Cabello & Donoso, 2013). Forests of this species were severely damaged by the fire of 2017 that burned nearly half a million hectares of land in Central Chile (de la Barrera et al., 2018). *P. boldus* is valuable for its active principles such as essential oils, alkaloids, and flavonoids (Jang et al., 2000; Jiménez et al., 2000; Kubinova et al., 2001; Schmeda-Hirschman et al., 2003; Vila et al., 1999). In this species, the flowering patterns of adult trees are largely known (Cabello & Donoso, 2013), but information on the age of first flowering is still lacking. Field observations in planting trials suggest that trees begin flowering at approximately 4 years of age. In this context, the objective of this communication is to report precocious flowering on 5-month-old *P. boldus* seedlings and comment on possible explanations for this phenomenon.

Method

The plant material used for this experiment corresponds to seed collected from mother trees in a site located close to the Río Maule, in the Maule Region of Central Chile (71° 44′ W, 35° 33′ S) (Figure 1). The seed collection site is characterized with sclerophyllous shrubs and trees of the Mediterranean-type ecosystem. Soil is poor, degraded, and with gentle to moderate slopes. At the canopy level, coverage ranges from 0 to 90%. The monthly average maximum and minimum temperature for the last 10 years in the study area reaches 28.4 and 1.6°, respectively, while the annual average precipitation for the same period is around 400 mm. Monthly average maximum and minimum temperatures have been recorded above 40° in January and close to –5° in May. The seeds were collected manually, directly from 10 mother trees that exhibited resprouting habit and an average height and crown width of 5 and 4 m, respectively. The mother trees were in a healthy condition and at

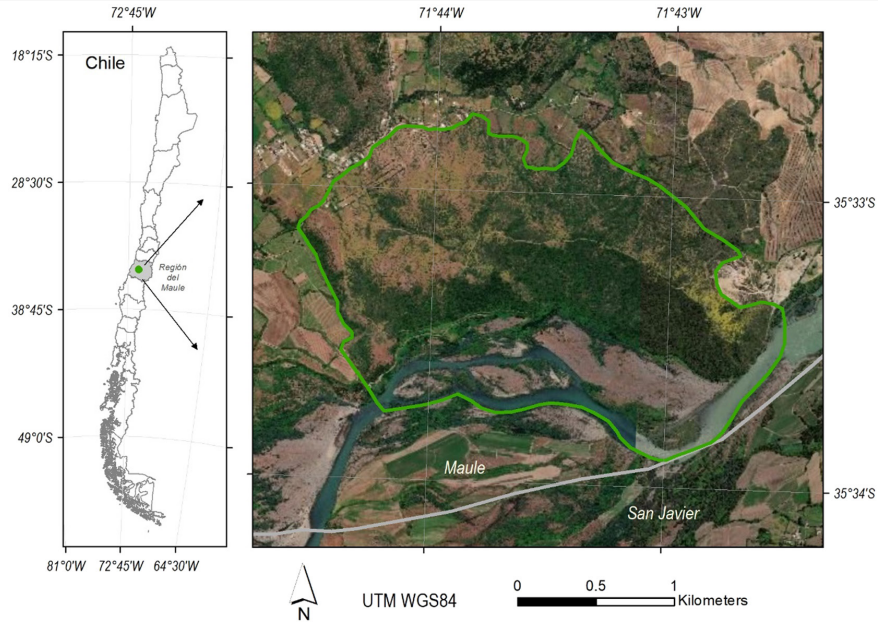

Figure 1.
Location of the seed collection site in the Maule Region of Central Chile.

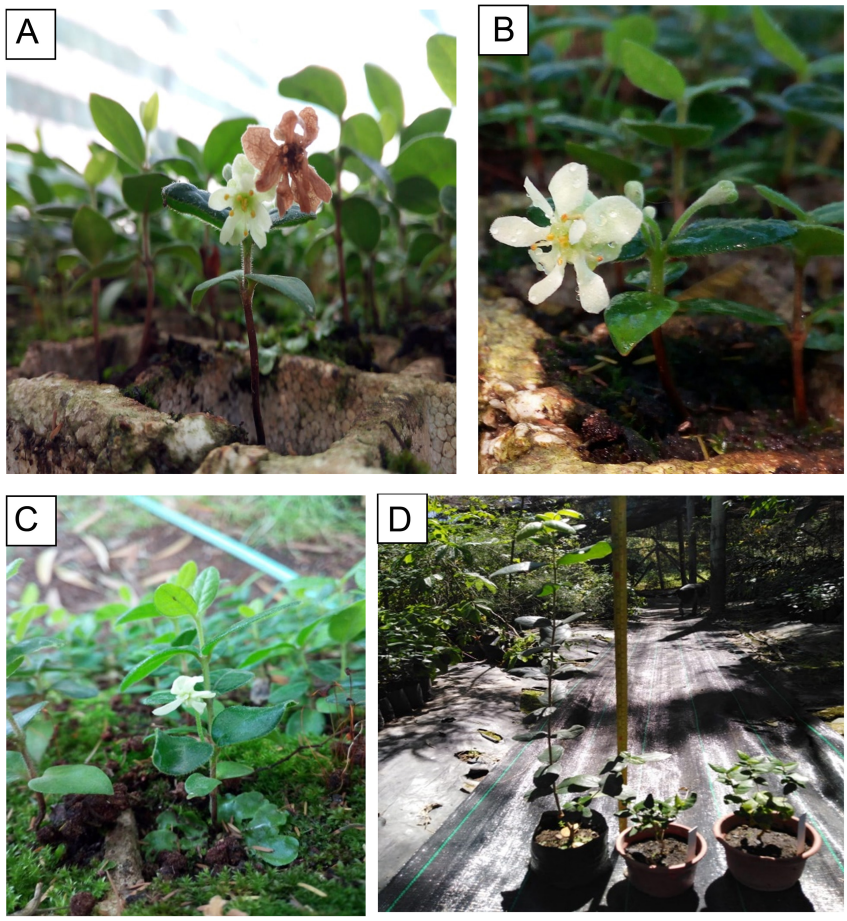

Figure 2.
(A) Senescence of a flower. (B) Flowering seedling. (C) Malformed flower. (D) Height growth of P. boldus *plants that flowered (tall plants, 70–80 cm) and not flowered (short plants, 7 cm).*

approximately 40 m apart from each other and were growing on clayey and compacted soils with slopes of less than 5%.

The cleaning and sowing of seeds, and the seedling cultivation was carried out in the facilities of the Jardín Botánico at the Universidad de Talca, Talca city, Maule Region. As a pregerminative treatment, the seeds were washed and the pulp (pericarp) was extracted (Cabello & Donoso, 2013). Seeds were sown at the end of July 2017 and seedlings were cultivated under greenhouse conditions with temperatures between 25 and 30°. Plants received the natural light of the nursery facilities, i.e., 10 hours of light and 14 hours of darkness in winter, and 14 hours of light and 10 hours of dark during spring–summer. 3000 seeds were sown in trays of 84 cavities with a volume of 100 mL each. Nondisinfected compost mixed with sand at a ratio of 3:1 v/v was used as growing substrate. During the seedling cultivation period, two irrigations were carried out daily for a period of 6 months. The flowering period was from November 15 to December 6, 2017, and flowering was evaluated by visual inspection.

Results and Discussion

Only three seedlings of a total of 3000 seedlings cultivated produced viable flowers (Figure 2A, B, C). The total number of flower buds was six, of which four finally turned into flower with no seed formation, and one of them had malformations. No second flowering was observed on these seedlings, and the vegetative growth was clearly decreased due to the energy spent in the development of reproductive structures. At the end of November 2019, i.e., 28 months after sowing, the seedlings that presented flowers had 7 cm of height, while the non-flowering seedlings had an average height between 70 and 80 cm (Figure 2D). From our results, it can be deduced that the conditions in which plants were cultivated did not exert an influence on the phenomenon of early flowering observed. In our trial, all seedlings were grown under homogeneous conditions of temperature, irrigation, and photoperiod, and no flowering inducers based on gibberellins were used. It is known that light intensity, temperature, and plant growth regulators induce precocious flowering (Gantait et al., 2012). It might be possible that genetic factors have controlled this isolated event. Heritability (i.e., the proportion of phenotypic variance attributable to genetic variance) of flowering is under important genetic control (Tsubomura et al., 2012). The material used in our trial corresponds to seeds with unknown father, so it is unknown what is the genetic contribution of male parents to this trait and whether it is inherited to the offspring. Pasiecznick et al. (2020) observed that seedlings of *Prosopis pallida* (H. & B. ex. Willd.) H.B.K. begin flowering at 3–4 months after germination and authors pointed out that possible candidate genes may control this event. Contrary to this, Vakshasya and Rawat (1986) observed flowering in 9-month-old *Dalbergia sissoo* Roxb plants and considered the event as a mutation and not as an inheritable characteristic. The latter situation could be similar to our results but needs confirmation and explanation. On the other hand, high temperatures have been observed to induce flowering in *Arabidopsis thaliana* (L.) Heynh. (Balasubramanian et al., 2006). In our test, the seeds come from mother trees that are characterized by growing in sites with high temperatures. In this sense, it is interesting to project the flowering performance of *P. boldus* under climate change conditions, since climate change has caused an increase in temperature and prolonged droughts in the Mediterranean-type ecosystem of Central Chile. Early flowering could represent an adaptation of the mother trees to ensure their reproductive success in sites with adverse environmental conditions. In sites with persistent droughts, this would ensure that plants that have a low probability of survival leave offspring for the next generation. However, these hypotheses need to be tested with multifactorial trials over several years of measurements.

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