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Scheduling Flowering in *Metrosideros excelsa* (pohutukawa)[©]

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INTRODUCTION

We have been working on a number of plants native to New Zealand to bring our knowledge to a stage at which some of them could be of use in the floricultural industry, either as cut flowers or flowering pot plants. Candidates receiving the greatest attention to date have been members of the Pacific genus *Metrosideros*, especially the New Zealand Christmas tree or pohutukawa (*M. excelsa*), and the colourful native legumes *Sophora* (kowhai) and *Clianthus* (kowhai ngutukaka or kaka beak). More recently, flowering in *Phormium* (flax) has been studied, and we are extending our findings in *Metrosideros* to plants in the closely related *Eucalyptus* group.

There are three parts to our research on pohutukawa: overcoming juvenility in micropropagated plants (i.e., making the plants become competent to flower as soon as possible), understanding the environmental signals that trigger flowering, and working out the conditions needed to control the timing of flowering and the effects on flower quality (Clemens et al., 2002). Working on overcoming juvenility has led to a theoretical breakthrough that could have far-reaching implications to the way we prune and train trees (Sismilich et al., 2003a, b). However, here we want to briefly review the results for controlling the triggers for flowering, and the accelerating and braking of floral development so that quality blooms can be produced to a set schedule.

RESULTS AND DISCUSSION

We showed that pohutukawa is a facultative short day plant: plants kept in long days initiated few flowers, whereas those in short days flowered as if they had been allowed to go through the naturally shortening days of autumn. Plants also needed to be cooled for flowers to form properly (Henriod et al., 2000). To refine these effects, we studied the effect of irradiance (the quantity of photosynthetically active light) during floral induction on flowering. Most people have found that the more light a flower crop is given during the early stages of floral development, the more flowers are produced. However, this was not the case in our experiments with pohutukawa. Although increasing light did increase flower number up to a certain, optimum level ($\sim 550 \mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), flowering became worse under higher light conditions (Henriod et al., 2003). Plants flowered poorly under low light ($\sim 200 \mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) (Fig. 1). All plants had been transferred to a forcing greenhouse for evaluation after 10 weeks induction treatment, so these effects were caused at or before microscopic flower buds had formed.

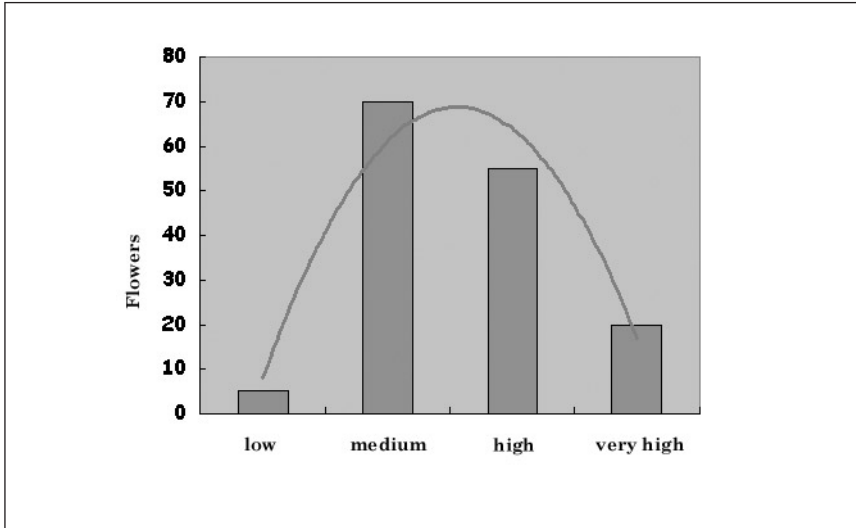


Figure 1. Representation of the effect of irradiance (photosynthetically active light) applied during floral induction on flower number in pohutukawa (*Metrosideros excelsa*). The optimum corresponds to an irradiance of $\sim 550 \mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$.

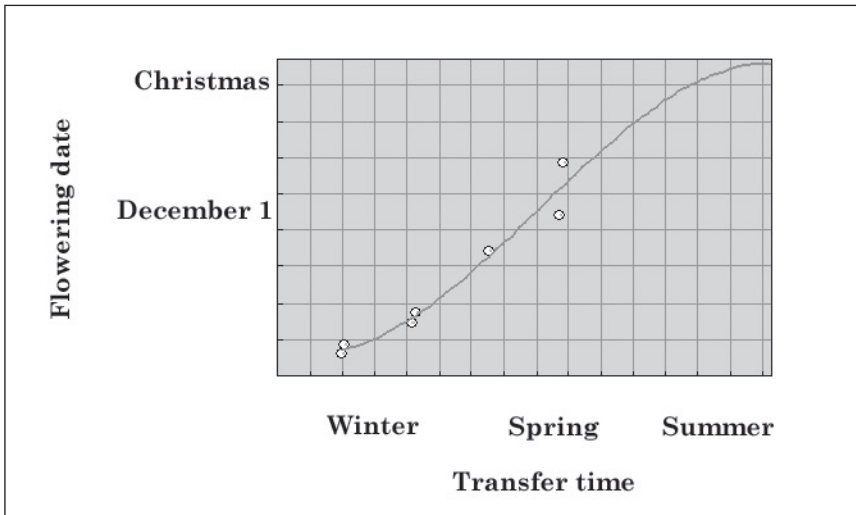


Figure 2. Representation of the effect of transferring plants of pohutukawa (*Metrosideros excelsa*) from cool to warm growing conditions at different times during late winter and spring. Transfer during mid-spring results in flowering in early December rather than mid-summer.

Having established optimum conditions for floral induction and subsequent development, we wanted to test ways to both speed up and slow down flower opening to enable pohutukawa blooms to be produced when they would be most needed, e.g., in the weeks leading up to Christmas. Pohutukawa trees in the southern hemisphere tend to flower at or just after Christmas/New Year, rather than in the weeks leading up to Christmas. However, plants grown in containers and moved between heated

and cooled greenhouses could be made to flower several weeks earlier, the exact timing of peak flowering depending on temperatures and the timing of transfers. As an illustration of the effects that were achieved, plants flowered on 1 Dec. (early summer) when transferred from cool to warmer conditions in mid-spring. Plants not transferred flowered on 31 Dec. (Fig. 2). Provided the treatments were carefully applied, there were no adverse effects of forcing on flower number or quality.

We have also investigated the effects of cool store temperature on the timing and quality of flowering in pohutukawa. Whole plants, with flowers well developed but in tight bud, could be stored in the dark at $<10^{\circ}\text{C}$ for several weeks without ill effect. Flower opening was rapid once plants were removed to the light and warmer growing conditions. There were no apparent effects of ethylene on flower drop under these storage conditions, although we had earlier shown that individual cut flowers could be made to fall by ethylene treatment (Sun et al., 2000).

Taken together, these light and temperature manipulations could be used to schedule flowering in pohutukawa over several weeks once flowers had been initiated under natural (autumn) conditions (Sreekantan et al., 2001). Scope for controlling the initiation of flowers (the early stages of flower formation) out of season is more limited as inductive treatments (i.e., short days) would appear to need to be applied for several weeks (Henriod et al., 2000).

The timing of floral development in *Sophora* and *Clianthus* is very different from that in *M. excelsa*, e.g., flowers are initiated practically throughout the year in *Clianthus* suggesting a good prospect of scheduling flowering *Clianthus* pot plants over a long period. Preliminary work with cut flowering branches of *Clianthus* shows that these have a useful vase life provided postharvest treatments are applied. All of our environmental work with native New Zealand plants is complemented by research at the molecular level to help us understand the genetic mechanisms underlying flowering in these exciting new floricultural subjects.

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