Hastening and Controlling Flowering in *Metrosideros*

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When cultivars of *Metrosideros* are micropropagated, plants typically revert to the juvenile phase, becoming bushy and hard to handle in the nursery, and bearing leaves similar to those of young seedlings. Critically, this rejuvenation also causes micropropagated plants to lose the ability to flower. We are exploring the potential of the traditional techniques of restricting roots, and training and restricting the shoots to hasten maturation in rejuvenated plants. Shoot restriction was more effective than root restriction in returning plants to the adult leaf morphology. We are also monitoring shoot growth and floral development in mature *M. excelsus* plants growing in the field to determine how the timing of apical shoot abscission affects the ability of buds to be receptive to signals that will initiate floral development.

INTRODUCTION

Understanding the course of vegetative and floral development in mature plants growing in the field is an important foundation to the study of plants in the production setting. Although the timing of shoot growth and its characteristics have been broadly described for *Metrosideros* (Dawson, 1968), we do not know when flowers are initiated, why some shoots are floral and others vegetative, and why some flowering shoots bear more flowers than others. Detailed studies, similar to those made by Snowball et al. (1995) for kiwifruit, are being carried out for shoot growth and development in mature *M. excelsus* plants growing in the field.

A goal for horticulturists for many centuries has been to cause woody plants to flower earlier than they would normally. Not surprisingly, many techniques have been used to cause precocious flowering, including root restriction, training regimes, and (more recently) chemical plant growth regulators. Woody crop plants studied intensively in New Zealand include *Citrus* (Snowball et al., 1994) and kiwifruit (*Actinidia*) (Davies, 1991; Snowball, 1995). These workers described the annual changes taking place in the architecture, leaves, and flowering shoots of their plants. They also showed that flowering can be accelerated by training long, unbranched shoots of their plants. Plant growth regulators that inhibit vigorous vegetative growth, e.g., paclobutrazol, can also be beneficial for flowering (Snowball et al., 1994). Resuming our earlier work (Oliphant et al., 1992), we are using these techniques to accelerate and enhance flowering in the ornamental woody genus *Metrosideros*, paying particular attention to micropropagated cultivars.

MATERIALS AND METHODS

Monitoring Mature Plants. Mature plants of *M. excelsus* were monitored for 12 months in the field to establish the timing of shoot growth and floral initiation. Shoots were tagged on three trees in midwinter, and the diameter of overwintering buds measured. Buds were classified into seven size classes based on bud diameter, ranging from 1.5 to 3.0 mm (size class 1) to 5.6 to 6.0 mm (size class 7). Buds were examined in the field every 2 to 4 weeks through bud break and flowering.

Root and Shoot Restriction. Micropropagated plants of *M. excelsus* 'Scarlet Pimpernel' were grown in containers of five differing volumes (0.2 to 1.8 litre) to apply different levels of root restriction. The containers were made from lengths of water conduit of differing diameter, which were cut into 110-mm sections. Woven fabric that would allow water penetration while restricting root growth was attached to the "base" of each section. Plants were transplanted into the pots using a growing medium that could be readily washed from roots at harvest, and containing controlled-release fertilisers. Over the following 9 months shoot growth in half the plants was restricted by removing all axillary shoots to give single-stemmed plants. Shoots were unrestricted in the other half which were allowed to branch freely. Shoot growth was monitored regularly before a single destructive harvest in which detailed measurements were made of the changes taking place in the leaves as the plants grew and matured, and the dry weights of plant parts determined.

RESULTS AND DISCUSSION

Monitoring Mature Plants. The majority of overwintering buds on mature trees in the field broke in September-October. If they were vegetative buds, they grew out into leafy shoots. Subsequently, the elongating shoot tips typically abscised, leaving leafy shoots with 2 to 5 nodes. Buds that were floral developed slowly until late December, when the individual flowers opened.

Many of the smallest overwintering buds (size class 1) did not break. Those that did break were predominantly vegetative, indicating that they had not been receptive to conditions suitable for floral induction in the previous months. Progressively larger overwintering buds were more likely to break, and the proportion of these that were floral increased up to bud size class 5 (Fig. 1). Larger floral buds contained more flowers than the smaller floral buds.

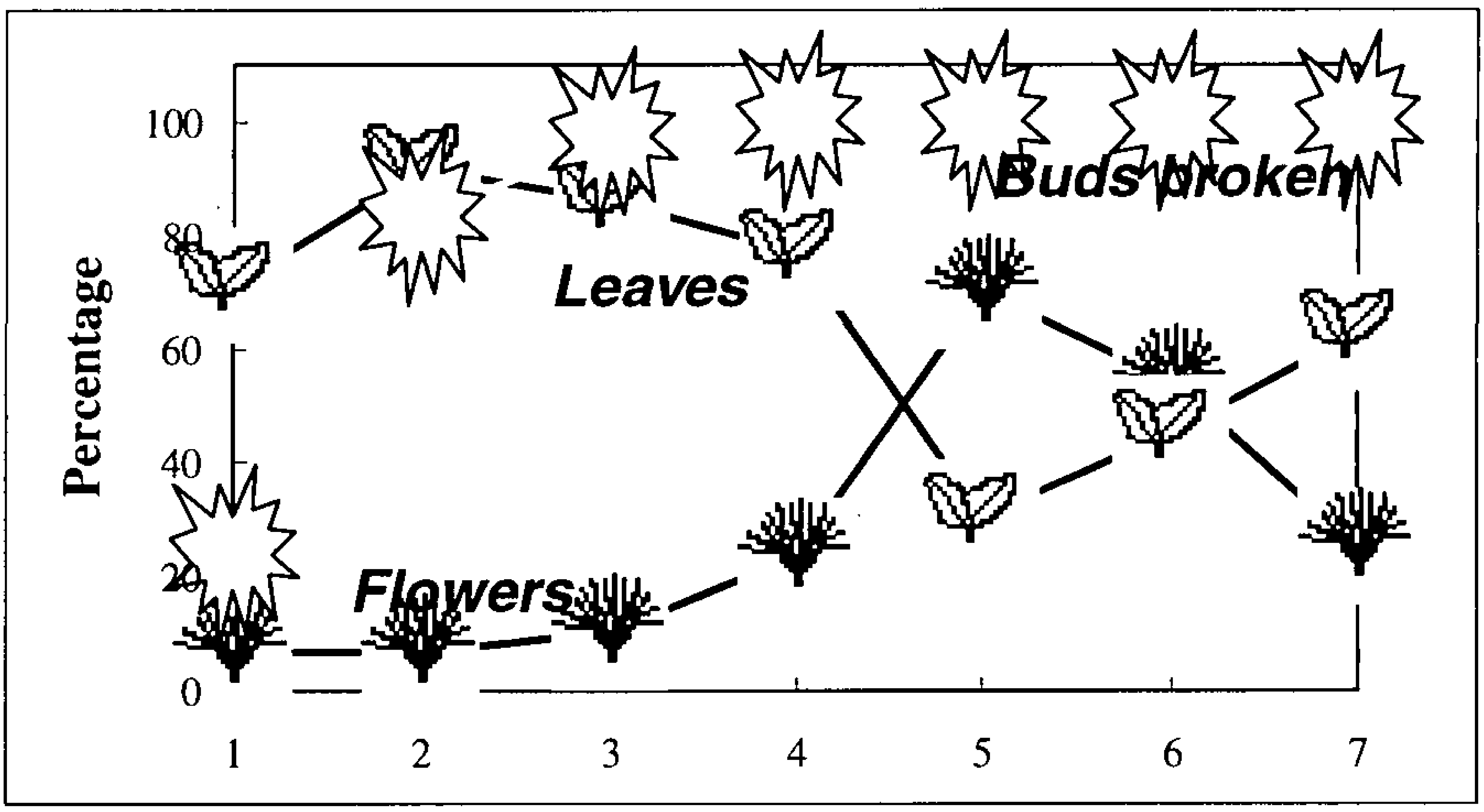

Figure 1. The percentage of overwintering buds in seven different size classes that broke in spring ("buds broken"), and the percentages of breaking buds that developed as vegetative shoots ("leaves") and floral shoots ("flowers"). Means are for 30 buds within each size class.

Surprisingly, the largest overwintering buds were more likely to be vegetative than floral, indicating again that these, like the smallest buds, had not experienced floral inductive conditions (Fig. 1). Abscission of the apex of the elongating vegetative shoot is a characteristic feature of *M. excelsus* and related species (Dawson, 1968). We believe that the ability of buds to initiate flowers may depend on the timing of apical shoot abscission in relation to temperature and photoperiodic signals inductive for flowering, and are testing this hypothesis in the coming season.

Root and Shoot Restriction. Micropropagated plants of *M.* 'Scarlet Pimpernel' responded to both root and shoot restriction treatments. Judging from the changes taking place in leaf shape, size, and spectral qualities, plants grown as single-stemmed plants matured much more rapidly than those allowed to grow branched. Bushy plants bore leaves that resembled those on the original rejuvenated liners (pointed and glossy green), whereas leaves on the single-stemmed plants were similar to those in adult plants (rounded and grey on the under-surface).

Branched plants weighed 2 to 3 times more than unbranched plants because branched plants developed many branches whereas single-stemmed plants were allowed to bear only one pair of leaves at each node with no axillary shoots. Branched plants also experienced greater root restriction in the smaller pots than the unbranched plants, root dry weight being significantly reduced. Unbranched plants had smaller roots than the branched plants, and were not restricted by the smaller pot sizes.

Preliminary results suggest that the root restriction experienced by the branched plants growing in the smaller pots did not accelerate the return of micropropagated plants to mature leaf morphology. Reversing the rejuvenating effect of micropropagation is, therefore, more likely to be successful by training rapidly growing single-stemmed plants, similar to the way Snowball et al. (1994) treated container-grown citrus, than by restricting root growth.

Temperature and day length treatments have been used successfully to bring about flowering in New Zealand woody ornamentals, e.g., *Hebe* (Noack et al., 1996) and *Leptospermum* (Zieslin and Gottesman, 1986). We are also using temperature and day length to manipulate flowering time in plants of *Metrosideros* that have been brought to the stage of being able to flower. The progress of shoot growth, floral initiation, and flowering in these plants will be tracked over the coming year. These growth studies are being complemented by analysis of the expression of genes associated with flowering and changes taking place in endogenous plant hormone (gibberellin) concentrations.

Acknowledgements. This work is part of the Native Ornamental Plants research programme of the Public Good Science Fund (Contract CO2626). Thanks are expressed to the Massey University Research Fund for additional support, and for the assistance of S. Haslett, D. Kerr, A. Winger, and S. Vangala.

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