

Colour is important in fruits and vegetables as well as in flowers. Enhanced post-harvest life is important in almost all horticultural crops. Horticultural crop growers will also benefit from herbicide tolerance, disease and insect resistance, drought and frost tolerance, and other novel traits being introduced to vastly improve the quality of their crops, to reduce their costs of production, and to help them to reliably produce their crops in the face of the every day uncertainties of weather, pests and disease. The tools exist to develop these products. Those groups willing and able to commit the funds and energy to applying these tools have a most attractive and potentially rewarding opportunity.

CHEMICAL CONTROL OF PLANT GROWTH

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This paper reviews current commercial developments in plant growth control of nursery plants in Australia, particularly in New South Wales.

MATERIALS AVAILABLE

Growth regulator chemicals available in Australia were reviewed recently (9). Regarding synthetic plant hormones of the gibberellins only GA₃ is used to a very limited extent for plant growth control. This also applies to the cytokinin N⁶ benzyl adenine (BAP). Otherwise, growth regulator chemicals such as paclobutrazol (Bonzi[®]) (now registered), chlormequat (CCC), and daminozide (SADH) would be preferred. Dikegulac-sodium (Atrinal[®]), is not available commercially in Australia.

It should be noted that, with the exception of paclobutrazol, which has been developed specifically for use on ornamentals, registered uses and formulations of both chlormequat and daminozide are limited. In New South Wales use permits are available for out-of-label usage.

Paclobutrazol is formulated as a 4g per litre suspension concentrate registered as Bonzi[®]. It is taken up passively through leaves, stem tissue, or roots. That which enters through stems and roots is transported in the xylem to growing points. Active compound reaching sub-apical meristems inhibits gibberellin production.

The direct morphological consequence is a reduction in vegetative growth. There is also a stimulation of flower production in some species.

Daminozide is available as a wettable powder containing 850g/kg active ingredient (Alar[®]). It is mainly absorbed slowly through leaves and best results are obtained under slow drying conditions. Daminozide slows down and reduces the amount by which cells expand after they are formed at the growing point, causing shortening of the internodes. It also reduces apical dominance so that increased branching and flower bud formation results. With both daminozide and paclobutrazol there is often an increase in chlorophyll, giving darker foliage.

Chlormequat (Cycocel[®]) is a liquid formulation containing 100g/litre active ingredient. The mode of action is not fully understood but it is an anti-gibberellin which results in reduced internode length in sensitive plants.

SPECIES RESPONSES

Paclobutrazol has been demonstrated to be active on over 60 species of ornamental plants without phytotoxicity. The magnitude of effect is usually proportional to the rate of application. There is generally a wide margin of safety between rates required to give desired horticultural effects and those at which phytotoxicity could occur. Because of this activity, combined with a lack of adverse side effects, it is anticipated that paclobutrazol will exhibit good cost/effectiveness compared with other plant growth regulators. This has been found on, for example, *Impatiens wallerana* 'Super Elfin Blush' in America (1).

Results of trial work with paclobutrazol at the Horticultural Research Institute, Knoxfield, Victoria have been reported by Wilkinson and Padgham (10). They also include guidelines for use as a soil drench and spray on a wide range of ornamentals, some of which are not shown on the current label. Several of these and others not described have been treated commercially with growth regulators. Results are discussed below.

Indicum Hybrid Azaleas. Data from Wilkinson and Padgham (10) comparing Bonzi[®] and Alar[®] are shown in Table 1. However, a number of commercial cultivars have been screened at a Bonzi[®]

Table 1. Effect on plant height and flowering of *Rhododendron* 'Pink Phryne' when growth regulators are applied.

Treatment	No. of appl.	Produce rate (ml/litre) or (g/litre) +	Final plant height (cm)	Total flower number
Bonzi spray	3	31.3	16.8	18.5
Alar spray +	1	6.0	16.0	12.2
Untreated	0	0.0	21.0	12.4

spray rate of 125ml/litre. Only some cultivars responded well showing good branching and enhanced flowering (Barrett, unpub.). Further work is needed to ensure that there is no delay in flowering and to determine sensitive cultivars.

Australian Natives. The quest to develop the Australian native flora as ornamental potted plants is of much interest. Some species are vigorous growers requiring the use of growth regulators. Geraldton wax (*Chamaelium uncinatum*) is one such plant. Shillo, et al (6) reported that both chlormequat and daminozide controlled height. However Lamont (2) found no response to daminozide but both chlormequat and paclobutrazol (soil applied) were effective, paclobutrazol also increasing flowering.

Geraldton wax is now being treated commercially by a number of nurserymen.

Paclobutrazol also reduced height in *Pimelia linifolia* 'Diamond Head' when applied as a compost drench whereas foliar-applied daminozide was ineffective (Lamont, unpub.).

Work by Price (unpub.) showed that pot drenches of paclobutrazol can be used to reduce the growth of *Crocea* (hybrid), *Callistemon citrinus* 'Western Glory', *Grevillea* 'Poorinda Constance', *Erica cerinthoides*, *Ceanothus papillosus* var. *roweanus* 'Blue Pacific' [Californian native; ed.] *Melaleuca lateritia*, *Acacia floribunda*, *Eucalyptus nicholii*, and *Kunzea baxteri*. *Boronia megastigma* 'Lutea' appears to be resistant, which has been confirmed by commercial experimentation. Bonzi[®] increased flowering in the species shown in Table 2.

Table 2. Effect of Bonzi[®] on flowering of two species

mg a.i./pot	<i>Erica cerinthoides</i>		<i>Ceanothus papillosus</i> var. <i>roweanus</i> 'Blue Pacific'	
	Bud no. 14/8/86	Flwrs open 9/9/86	Bud no. 1/9/86	Flwrs open 9/9/86
0.0	4.2	1.0	0.2 C	0.0 C
2.0	9.7	2.5	6.7 A	1.1 AB
4.0	8.7	3.5	6.2 A	1.3 A
8.0	9.7	4.4	2.8 B	0.5 BC
5% L.S.D.	10.8	4.3	3.4	1.1

Other species tested which show promise include *Ceratopetalum gummiferum* 'Magenta Star' and *Eriostemon myoporoides* 'Swanson', with good height control, increased branching, and more early flowers.

Boronia heterophylla has responded well to a foliar applied cytokinin, N6 benzyladenine (BAP) (9). This material will provide development of side shoots without any severe retardation (3). This may be of particular interest in view of the lack of sensitivity to paclobutrazol in *Boronia* species.

Chrysanthemums. Daminozide has been used widely to control growth and is very effective. Paclobutrazol applied as a spray has not been effective in certain cultivars and may have to be applied twice. There may be a delay in flowering.

Climbers and Creepers. Chlormequat has given some growth control in Bougainvilleas at high rates. Paclobutrazol is being tested by a number of nurseries but it is too early to assess results.

Mandevilla sanderi and *Clerodendron thomsoniae* have been well controlled with paclobutrazol applied as a spray with no effect on flowering. Leaves were darker green.

Fuchsias. Atrinal[®] was used on this plant with some success. Paclobutrazol has been shown to be effective in USA (5) and has been experimented with by several growers in New South Wales as a spray. Certain cultivars such as 'Winston Churchill', 'Lord Byron', and 'La Fiesta' have responded well. With some other cultivars a delay in flowering is suspected and growth control may be inadequate.

Hydrangeas. Alar[®] has been used by a few growers. Some cultivars may not benefit from the use of plant growth regulators. Paclobutrazol has been compared with daminozide in USA giving similar responses (4).

Impatiens. This is a very popular ornamental in USA and Europe and is gaining popularity in Australia. Plant growth regulators are widely used in the USA and some recent research has been referred to (1). Paclobutrazol is proving very successful in New South Wales giving good growth control and enhancing flowering.

Poinsettias. Both Alar[®] and Bonzi[®] have been utilized here as spray applications with good results on all cultivars tested. These materials have reduced plant height whilst maintaining an attractive darker green colour and enhancing bract colouration. Results with paclobutrazol in the USA were reported in 1981 (8).

Other Plants. Several plants have been tested with Bonzi[®] by nurserymen where benefits were expected, particularly for growth control. These include *Acalypha* 'Summer Love' (good response); begonias; *Bouvardia* (variable); geranium (good); *Pentas lanceolata* (variable); and *Verbena tenuisecta* (purple and white forms) with excellent results particularly in the production of cuttings.

Zantedeschias. These plants respond well to plant growth regulators (7).

DISCUSSION

The availability of paclobutrazol has stimulated renewed interest in the use of plant growth regulators in Australia. However, as limited research is being undertaken, nurserymen are experimenting themselves.

Results to date suggest that despite the potency of

paclobutrazol and its lack of adverse side effects, timing and concentration are important.

It is also evident that cultivars in some species, such as chrysanthemum, may show differing responses. In the case of *Boronia*, no response has been found.

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