Techniques to Modify Plant Form for Ornamental Crops©

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INTRODUCTION

Growers and exporters tell us that to compete in domestic and export markets, we must deliver high-value product into niche markets. To achieve this, within my experience, I interpret this to mean each of us needs to focus on five key components, i.e., delivering plant products that are:

1) Novel and innovative: To me this highlights the ongoing need for breeding of new crops and selections.
2) Of a suitable quality: This refers to the product meeting the market specifications for height, colour, size, form, post-harvest performance, etc.
3) "Clean": For example, free of known viruses and free of pests and disease.
4) On time for particular market windows such as Christmas, Mother's Day, etc.
5) Targeting a solid market: This requires good market knowledge and contacts.

This is a long list of topics to deal with. In this presentation I have chosen to focus upon just one of these, "quality," focussing in particular on plant form. What do we mean by plant form? In this presentation I use the examples of both height and branching, or what we might refer to as visual "fullness" of plants.

As evident during the California Spring Trials in March/April 2011, plant form is a "hot" topic amongst breeders of ornamental plants. Examples included Syngenta Goldsmith Seeds' *Petunia* Ramblin™ Nu Blue petunia which, compared with *Petunia* Easy Wave™ Blue spreading petunia, is visibly more compact and floriferous. Similarly, Syngenta's *Antirrhinum majus* 'Arrow' (snapdragon cultivar) had clearly more well-developed and floriferous branches than a competitor's cultivar on display. PanAmerican Seed's *Impatiens* Impreza Series was being promoted as superior to its competitors by having more branches with a compact habit.

Throughout the preceding examples seen during the California Spring Trials, a repeating feature was the quality of the plant product being associated with "more branches." As growers, this therefore brings us to the obvious question as to what practical techniques can we use to achieve "more branches" in the plant products we grow?

Before exploring some techniques available, it's worth considering a little background information about branching in plants. We accept that plant growth regulators, which naturally occur in plants, effectively control the amount of branching that occurs (Shimizu-Sato et al., 2009). Auxins, one of the key groups of plant growth regulators involved, are produced within the apical buds and developing leaves of plants. Once produced, these auxins are transported downwards within the plant. At the same time, however, cytokinins are often produced by the plant in its roots, and are transported upwards. If we try and keep it simple, the net result of this production and transport of both auxins and cytokinins is that whether or not a bud grows out to become a branch is the net result of the antagonistic effect of auxins and cytokinins (Shimizu-Sato et al., 2009). More specifically, if the amount of cytokinin increases and/or auxin decreases, the net result should be that more branching occurs.

SOME AVAILABLE TECHNIQUES

Pinching and Pruning. In terms of practical techniques growers can use to increase branching, the preceding background about plant growth regulators allows us to now understand what happens when we pinch or prune at the top of a stem. When we do this, we are effectively removing the site of production of auxins (McSteen and Leyser, 2005). With less auxins to be transported downwards towards axillary buds, the balance between auxins and cytokinins now tips in favour of the cytokinins, resulting in these buds growing into branches.

Plant Growth Regulators. Following the logic that the balance between auxins and cytokinins can offer possible techniques to trial, it is little wonder then that applying cytokinins to your plants is another technique that has commercial application (Jeffcoat, 1977). In our recent investigations with hybrid gentian (*Gentiana*) selections, we found that the cytokinin thiodiazuron (TDZ), applied as a 100 ppm drench to the growing medium, resulted in increased buds, i.e., branches, on the crown (Uttara Samarakoon, pers. commun., Massey University, New Zealand). In an herbaceous perennial-like gentian, having more branches formed increases the potential for more flowering stems.

While on the subject of plant growth regulators, it is appropriate to remember that they are also involved in height control in ornamental plants. Application of chemicals such as Paclobutrazol® [N-dimethylaminosuccinamic acid, α-tert-Butyl-β-(4-chlorobenzyl)-1H-1,2,4-triazole-1-ethanol; ICI Chemicals] influences the content of plant growth regulators, and when applied as a drench to growing medium of *Zantedeschia*, total plant height can be reduced to give plants suitable for sale as potted flowering plants (Reiser and Langhans, 1993). In investigations carried out at New Zealand's Nursery Research Centre, depending on the height reduction of *Zantedeschia* plants desired, rather than drenching the growing medium, tubers could be soaked in Paclobutrazol® prior to planting, at concentrations ranging between 80 and 160 ppm, for a duration of either 24 or 48 h (MacKay et al., 1986).

Breeding. As evident from my earlier comments about the new and improved cultivars of petunia, snapdragon, and impatiens seen during the California Spring Trials, breeding is also a practical technique to improve product quality via modifying plant form. While our experience with ornamental crops has been that you need to be prepared to wait for 10–15 years before new cultivars are a commercial reality, the genetic diversity among different species available to us makes it worthy of consideration. With modern breeding techniques such as embryo rescue available, undertaking extremely wide crosses can now be given serious consideration. A case in point here has been the successful crosses between *Sandersonia* × *Gloriosa* (Burge et al., 2008) and *Sandersonia* × *Littonia* (Morgan et al., 2001) which have resulted in a range of novel genetic combinations with a diverse array of plant forms. These forms vary between those with short stems and clusters of flowers at the top, i.e., suited for marketing as potted plants, to those which are taller with flowers along their length, suited for cut flowers.

A breeding programme targeting new gentian cultivars for the cut flower market has led to a wide diversity in plant forms. As demand for potted plants has also increased, our initial strategy has been to use the same gentian cultivars for both cut flower and potted plants. To date, however, this strategy has not achieved commercially viable results as the natural plant form does not lend itself for both purposes. As an alternative, greater success has recently been achieved using some of the genetic diversity elsewhere within the Plant & Food Research breeding programme, with plants that naturally have shorter stems and greater branching.

Propagule Source. As part of our strategy to reconsider the diversity of different gentians from our breeding programme, we have also questioned the source of propagule we might best use in producing potted plants. For example, one unnamed selection, referred to here as "CV94," forms a clump with individual shoots reaching approximately 40 cm in height when grown as a stock plant in the open ground. Vegetative cuttings from emerging shoots in spring flower at the same time and reach approximately 30 cm in height, but show only limited evidence of branching. Hence, if used as a potted plant, three or more cuttings per pot would be required to create the visual fullness the market requires. In contrast, if instead of vegetative cuttings the propagule is derived from tissue culture, an individual plant in a 15-cm-diameter pot fills the entire pot to a height of 10 cm above the rim, creating the desired visual fullness and proportions. The resulting plant form was retained for more than 6 months, which should be desirable for marketing of most potted plants. Similar results have been achieved with one other unnamed selection of gentian, which leads us to suggest the use of different propagule sources is worthy of consideration when selecting different plant forms. At this point in time, we believe the change in form achieved reflects our ability to manipulate some of the plant growth regulators during the tissue culture process.

FUTURE PERSPECTIVES

Recently a new family of plant growth regulators called "strigolactones" have been identified as being involved with branching (Gomez-Roldan et al., 2008). Hence our knowledge of how plant growth regulators control branching in plants has now become that much more complex. At present little is known about how strigolactones are produced or how they work, but when present and active in plants, strigolactones actually inhibit branching. In terms of growers of ornamental crops using the application of strigolactones to control branching, the current price of US$5,300 per gram restricts its use to research institutions. However, a potential alternative strategy from our own research has illustrated that cultivars with lower strigolactone content are also more inclined towards natural branching. This therefore raises the possibility that in the future, perhaps we could be using strigolactone content as a screening tool within selective breeding programmes.

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