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The physiology and control of crown bud formation and development in gentians

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Abstract

The spread in time to flower harvest maturity and an inability to produce an adequate number of crown buds during crop establishment, were perceived as problems by commercial growers of gentians for cut flowers. By identifying and investigating plant and environment related factors that influence growth and development, the current thesis aimed to investigate both the causes of these problems and identify potential solutions.

Crown buds which appeared during the previous growth cycle were the source of floral shoot production and, in both true seedlings and clonally propagated plants, these buds typically originated on the transition zone between shoots and roots. When formed on the transition zone the first and, as a consequence, apical bud of the crown bud cluster, originated adventitiously. The individual crown buds which subsequently initiated within the cluster developed as axillary buds from that apical bud. As evident from the appearance of two to five times more crown buds and shoots, and crown bud clusters, the naturally occurring short photoperiodic regime promoted the crown bud formation process, compared to a long photoperiodic regime. With the application of Ethephon, or Ethephon followed by either Thidiazuron or Paclobutrazol, it was possible to achieve a similar increase in the number of crown buds under the long photoperiodic regime. In contrast to the strong photoperiodic response, exposure to the cooler temperatures experienced outside did not influence the crown bud formation process.

Once formed, crown buds were under different types and degrees of dormancy (i.e. endo, para or eco). Dependent on both the developmental stage of plants and the hierarchical position of buds within a crown bud cluster, shoot emergence and subsequent development to flowering varied in the quantity, quality of shoots, and timing in response to dormancy breaking treatments (chilling, gibberellic acid (GA_3), or clipping), Hence when applied prior to shoot emergence, application of chilling to plants of the cultivar ‘Diva’ resulted in an eight-fold increase in the number of floral shoots, along with a 83 day reduction in the spread in time to harvest maturity. The requirement of chilling could be substituted by GA_3. In contrast, when applied following the start of shoot emergence, only application of GA_3 was effective in increasing shoot emergence and narrowing the spread in time to harvest maturity.

Within a bud cluster, a positive relationship between duration to harvest maturity and a negative relationship with floral shoot length was evident with hierarchical position of the crown bud from proximal to the distal end. This influence of hierarchical position was most evident following application of chilling or GA_3, potentially explaining up to 28 days spread in duration to harvest maturity in 'Diva'. While the aforementioned factors related to shoot emergence, development and hierarchical position contribute to the sources of variability within a plant or an individual cluster, both the sources and extent of variation in time to harvest maturity, varied within cultivars, with wider spread in time to harvest maturity in 'Starlet' (41 days) than 'Diva' (35 days) and 'Spotlight' (29 days).

The present study has increased the understanding of factors contributing to growth and development of gentians as an ornamental crop. Treatments have been developed to allow manipulation of the formation of crown buds, subsequent emergence and compactness of flowering duration.

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List of Abbreviations

1-MCP	1-methylcyclopropene
ABA	Abscisic acid
AO	Acridine orange
BA	Benzyladenine
CRD	Completely randomised design
DNMRT	Duncan's multiple range test
ethephon	2-chloroethylphosphonic acid
FAA	Formaldehyde: glacial acetic acid: ethanol
FI	Flower initiation
GA	Gibberellins
GA3	Gibberellic acid
IAA	Indole-3-acetic acid
LD	Long photoperiodic regime
LSMEANS	Least square means
NAA	Naphthalene 1-acetic acid
NPA	Naphthalphthalamic acid
NZ	New Zealand
PAR	Photosynthetically active radiation
PBZ	Paclobutrazol
SAM	shoot apical meristem
SAS	Statistical Analysis System
SD	Short photoperiodic regime
T	temperature
TDZ	Thidiazuron

List of Publications

- Samarakoon, U.C., K.A. Funnell, D.J. Woolley, E.R. Morgan**. "Sources of Variation in Time of Harvest Maturity of Flowering Shoots in Three Cultivars of Gentian"** submitted for publication in New Zealand Journal of Crop and Horticultural Science. (Chapter 2)

- Samarakoon, U.C., K.A. Funnell, D.J. Woolley, E.R. Morgan. 2012 **"Temperature Impacts Changes in Crown Buds and Flowering of Gentian 'Spotlight'"** Scientia Horticulturae vol. 143(49-55)

- Samarakoon, U.C., K.A. Funnell, D.J. Woolley, G. Burge, E.R. Morgan. **"Initiation, Emergence and Development of Crown Buds in Gentians"** accepted for publication in Proceedings of International Symposium of Ornamental crops, IHC 2010. (Part of Chapter 3; included Appendix VI)