Interpreting Plant Architectural Design©

K.A. Funnell
The New Zealand Institute for Plant & Food Research Limited, Private Bag 11600, Palmerston North 4442, New Zealand
Email: keith.funnell@plantandfood.co.nz

INTRODUCTION

Using examples of both herbaceous and woody perennial plant species, this presentation profiles research focused on plant architecture currently being undertaken at Plant & Food Research. At this time, the primary focus of these investigations is branching. In terms of most crops of interest, but especially those grown for ornamental purposes, the extent of branching directly relates to our ability to deliver plants of high quality, by their visual "fullness" (Funnell, 2011).

Before exploring our recent experiences, 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 to 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 effects 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. While this simple scenario involving auxins and cytokinins is useful to explain branching, recently a 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 become that much more complex. The scientific community's knowledge about how strigolactones are produced and how they work is increasing very rapidly, but on a practical scale, strigolactones are best viewed as inhibiting branching.

HERBACEOUS PERENNIAL

Begonia boliviensis Hybrids

Plant & Food Research has been hybridizing *Begonia boliviensis* for use as a bedding plant and potted patio plant. International sales of cultivars developed to date continue to increase (e.g., 'Nzcone', marketed as Bonfire™), but there is a continued effort to increase and diversify the commercial range of cultivars available. To achieve this diversity, in addition to the breeding programme focusing on obvious attributes such as flower and foliage colour, architectural form has increasingly become a focus.

As evident during the process of making pre-selections of hybrids from the 2012-2013 growing season, a repeating theme of architectural form became evident. Those plants selected for their architectural form could be related to their adherence to the "Golden Mean" wherein the relative proportions of height, width, and depth approached the ratio of 1 to 1.618 (Sachs et al., 1976). While an important contributor to achieving these proportions was the overall plant height, as influenced by node number and internode length, the frequency of branching was also found to be a key determinant.

Those hybrids making it through the pre-selection process typically had a high frequency of branches arising from existing stems. This trait of high branch frequency being evident from early plant establishment provides us with a clear indication of an inherited trait for which to select, not only to provide plants of aesthetic proportions at point of sale, but also for sustained floral display.

WOODY PERENNIALS

While a key determinant of the architectural form of any woody perennial is the ability of buds to break into growth following completion of winter dormancy, this has not been the focus of our recent research. In contrast, we have focused on the development of branches during the current season of growth, i.e., sylleptic branching. By understanding what mechanisms control whether new branches arise from a leaf axil, we anticipate that we will be better placed to develop techniques for growers to use to control architectural form.

Acer palmatum

During the current 2012-2013 growing season, we have identified cultivars of *A. palmatum* with three different categories of sylleptic branching: free-branching, non-branching, and delayed branching. In addition, we have determined that a representative cultivar of the free-branching category contained comparatively lower concentrations of the branch-inhibiting hormone strigolactone, while the non-branching cultivar contained higher concentrations. This finding therefore supports the notion that strigolactones inhibit branching, and sets the scene for future research to determine techniques that can offer growers some degree of branching control. While hybridization and selection of *A. palmatum* is not part of Plant & Food Research's current activities, the possibility exists that the presence of strigolactones in young seedlings could be used for early selection of hybrids with either free-branched or non-branching traits.

Malus domestica

The establishment of a branching framework in the first season of growth from grafting is an important factor dictating the quality of apple stock. During this first season of growth, two or sometimes three cycles of branching may be evident, where a cycle comprises a period when branches develop, followed by a period where no branches develop from leaf axils. As with the cultivars of *A. palmatum* discussed above, determining what mechanism controls whether a bud in a leaf axil emerges as a branch, is the focus of our current research.

Using plants of 'Royal Gala' that contrasted in strigolactone content, during the 2012-2013 growing season we have been able to confirm that those plants with reduced strigolactone produced a greater number of branches. While these results appear to be in agreement with those for *A. palmatum* discussed above, the fact that the cycles of branching and non-branching still occurred indicates strigolactones do not have sole control over whether a bud develops into a branch. Again however, as part of a breeding programme for apples, the amount of strigolactone present in seedlings may be able to be used as a useful marker for the desired degree of branching.

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