

Plant Breeding at Auckland Botanic Gardens and Beyond

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Summary

Plant breeding programmes at Auckland Botanic Gardens have produced ornamental plants that perform well under New Zealand conditions. Trials are conducted to

evaluate plants for flowering, foliage and habit, and general plant health. Examples of breeding efforts related to selected plants will be described.

INTRODUCTION

In plant breeding, Auckland Botanic Gardens (ABG) is best known for developing the ‘Wiri’ series of *Veronica* (*Hebe*) and *Leptospermum*. Other crops that have been

developed include *Dahlia*, *Canna*, *Camellia* and *Hemerocallis*.

All plant breeding programmes at ABG primarily aim to produce plants that perform to a high standard and remain

healthy in Auckland conditions without applications of insecticides and fungicides. Seedlings are also evaluated for their ornamental qualities and garden performance with particular focus on high health. Trials are conducted to ascertain the best performing plants using criteria that consider flowering periods, foliage and habit, and general plant health. Our niche is to fill some of the gaps that are understandably unrealistic for most commercial plant breeders.

Numerous popular garden plants such as dahlias, camellias, azaleas, and chrysanthemums were not primarily bred for garden performance. Many were bred to produce exhibition-quality flowers for the show bench, while in recent times most ornamental commercial crops have been bred to have high aesthetic appeal at point of sale. Compact, precocious plants that flower heavily while still young have understandable appeal at point of sale, but often they do not perform sustainably well when planted into a garden or container.

Plant breeding is closely aligned with and ultimately dependent upon plant selection. In my view a programme will only succeed if the quality of the parent material is of the highest quality.

I have collaborated on several breeding ventures with Dr Keith Hammett, particularly with *Dahlia*. From Keith I learned the importance of having a plan that includes clear objectives, accurate documentation, and scouring every possible avenue to secure the best possible germplasm to execute the plan successfully.

Others who have made substantial contributions to the ABG breeding programme are Terry Hatch and the late Graeme Platt.

Terry Hatch has a contagious passion for plants and is always on the lookout for anything new, different, and ultimately superior. I learned from him the importance of assembling a wide array of germplasm and having an intimate knowledge of the plant groups that are being worked with.

Graeme Platt taught me that all plants are not created equal, and that there is a vast pool of plant material with unrealised potential. Although he was not a plant breeder, he introduced many of our most important garden plants, especially natives that he sourced mainly from the wild. Several of these were used as parents in my plant breeding programmes.

All three consistently exhibited a deep passion for plants and a dogged determination to make improved options available to our gardeners.

Veronica (Hebe) breeding

The *Veronica* breeding programme started at ABG in 1982. The first objective (prior to eco-sourcing) was to produce a form of koromiko (*Veronica stricta*) that was resistant to septoria leaf spot. I was nursery manager at the time, and for revegetation programmes we were growing large numbers of koromiko that invariably became riddled with spots. Ultimately, I found one plant that remained relatively free of disease and named it 'Wiri Spears' which we produced for plantings in Regional Parks.

Shortly afterwards, and for similar reasons, I raised 'Wiri Jewel', a form of *V. speciosa* that was relatively resistant to septoria leaf spot and downy mildew. 'Wiri Jewel' is the parent of several hybrids including 'Wiri Gem' and 'Wiri Charm'.

We decided to use a common prefix for all our cultivar names to associate them with

ABG and settled on 'Wiri' which was applied to all the *Veronica (Hebe)* and *Leptospermum* cultivars produced at the Gardens.

The objective of producing healthy hybrids was never lost, but over time more focus was put on improving aesthetic and performance characteristics.

Parent plants were grown in containers to facilitate hand pollination of flowers rather than just collecting open-pollinated seed as I had done previously. The laborious pollination process involved removing the corolla from the seed parent with tweezers which simultaneously removed the stamens and prevented self-pollination. Then pollen from the pollen parent was transferred to the stigmas of the seed parents.

The breeding process was simply to produce numerous seedlings and cull any that developed disease symptoms. Large numbers were produced, with only about 2% of the seedlings that were pricked out making it past the tube stage for subsequent pot and field trials. Most of these seedlings were later culled owing to unsatisfactory performance or appearance. I was initially looking for healthy high-performance garden subjects, and it was later that I realised that for a cultivar to be commercially viable it had to perform well in nursery production systems and look good at point of sale. To date, just 15 Wiri cultivars have been named by ABG from tens of thousands of seedlings raised. A few cultivars were given the Wiri prefix by others looking to take advantage of the commercial appeal of the brand at the time.

Veronica diosmifolia was used as one of the foundation parents as it invariably remains clean and healthy and passes

this characteristic on to its offspring. Crossing a pink-flowered form of *V. diosmifolia* with *H. speciosa* 'Wiri Jewel' resulted in 'Wiri Gem' and 'Wiri Charm' which have both proved popular with gardeners. 'Wiri Charm' is particularly popular in the UK.

'Wiri Mist' is a cross between *V. diosmifolia* and *V. albicans* and is invariably healthy and especially attractive when smothered with white flowers in late spring.

'Wiri Splash' deserves in my view to be more widely grown. It forms a healthy compact mound of green foliage tinged yellow and carries masses lilac flowers in early summer.

'Wiri Image' is another that could be grown more widely, although it is larger and not suitable for small gardens.

F₁ hybrid seedlings proved to be consistently uniform in appearance, but this was not the case with hybrids containing large numbers of species in their pedigree. Such hybrids often bear little resemblance to wild species, increasing opportunities to produce novel new hybrids.

A turning point in my understanding of the commercial viability of hebes came with invitations in 1990 and 1993 by Danish hebe growers to visit their growing operations. There I encountered hundreds of thousands of hebes in 10 cm pots, with 2 million or more produced annually for the European market, largely as house plants.

My plant breeding days were interrupted when I became manager of ABG in 1997 and most of the plant breeding activity at ABG paused.

Recently I have begun once again to dabble in plant breeding, especially with hebes, which I believe have untapped po-

tential as garden subjects and in commercial production. My main initial objective is to produce cultivars with performance and health attributes similar to 'Wiri Mist' but in a wider range of flower colours. The specific objectives of the programme are to produce cultivars with the following characteristics:

- remain healthy without pesticides
- are high performing garden subjects
- have buyer appeal in small pots at point of sale
- have attractive foliage
- remain compact
- have attractive flowers with significant peak flowering period
- ideally flower when grown in small pots

Many of the most colourful seedlings have *V. speciosa* in their pedigree and have inherited its disease susceptibility. Many also flower over a relatively prolonged period although not all produce a peak flush. Some of the most prolific flowering *V. speciosa* hybrids I have produced flower progressively as their branches extend, but the downside is they do not remain compact and therefore require annual pruning.

A large proportion of seedlings derived from 'Wiri Mist' produce healthy attractive healthy foliage but fail to flower sufficiently and therefore are culled. Those that flower sporadically without producing a significant main flush are generally culled. Rare exceptions are those with especially impressive foliage.

It has proved particularly challenging to develop hybrids that make outstanding garden subjects and also look attractive at point of sale. Based on extensive trials at Auckland Botanic Gardens it appears that many recently released hybrids have been selected primarily for their appearance at

point of sale as few have performed well when trialed as garden subjects.

The key plant breeding lessons I have learned are:

- start with a plan
- stick to the plan
- assemble the best possible array of germplasm
- research genetics (for compatibility)
- keep detailed records
- grow large numbers
- cull ruthlessly
- do not release anything until extensively trialed.

BREEDING PROCESS

Seedlings are germinated and pricked out. Seedlings grown in greenhouse for several weeks. Even in these relatively controlled conditions some die.

When large enough they are shifted outdoors. The attrition rate is high as any seedlings that develop downy mildew are culled. On average just 5% make it through this stage and are potted into 10 cm pots.

Seedlings that have attractive foliage and good form and still remain healthy are propagated by cuttings.

Cutting grown plants are further tested as pot plants and some are planted into garden trials.

Selected individuals are evaluated over the next 2 or 3 years to determine their suitability for container and garden use.

Some still develop disease symptoms and are culled. Those that remain healthy continue to be assessed for health, compactness and flowering performance. Those with a tendency to become woody are also culled. The majority of remaining

seedlings do not flower well enough to persevere with.

Hemerocallis

The daylily breeding programme at ABG commenced shortly after daylily rust (*Puccinia hemerocallidis*) was first reported in Auckland in 2011. The breeding programme was initiated in 2014 and has been led by Jack Hobbs and Emma Simpkins (née Bodley). The aim is to produce evergreen cultivars that remain healthy and produce prolonged displays of attractive flowers in a wide range of colours.

Daylily rust spread rapidly and soon most cultivars grown in Auckland became so debilitated they were no longer suitable for garden use. Typical symptoms are yellow pustules on the underside of the leaves that eventually cover much of the foliage. The rust is particularly severe in warm humid climates such as Auckland's.

Prior to the incursion of daylily rust large drifts of daylilies were planted at ABG. The first major trial was some 30 years ago when more than 400 cultivars were evaluated. From that trial we selected 40 cultivars that we used and recommended.

In December 2009 55 cultivars were planted in ABG trial beds and evaluated for five years. Just 12 cultivars were assessed as being suitable for ornamental use in Auckland gardens.

Daylily rust rendered many of the high performing cultivars identified in our trials unusable as garden subjects. Today few daylilies are rust free in Auckland, and those that do remain healthy can be hard to source. However, we have identified some cultivars that are still worth growing and the best of these have been included in our breeding programme.

'Squeaky' was chosen as the foundation parent as it was an outstanding performer in ABG trials and proved to be particularly resistance to rust disease. The yellow-orange flowers have a distinctive crinkle and although not the most impressive they appear for many months. The attractive evergreen foliage is narrow and spreads densely, making it an effective groundcover, and the plants invariably look healthy. In essence the ABG breeding programme aims to replicate the best attributes of this daylily in a range of different flower colours.

During the summer of 2014/2015 a selection of 23 rust-resistant cultivars was used to pollinate 30 plants of *H.* 'Squeaky' which was the sole seed parent. In the summer of 2015/2016 the number of pollinators was reduced to 12 rust-resistant cultivars used to pollinate 30 plants of *H.* 'Squeaky' which again was the sole seed parent.

Cultivars used as pollinators in the breeding programme include:

'Nashville' (evergreen, reddish flowers with yellow centres)

'Chicago Apache' (deciduous, pinkish red)

'Glitter' (yellow)

'Moon Goddess' (yellow)

'Chosen One' (lemon).

'Peek a Boo Eyes' (evergreen, soft yellow with crimson eye)

'Baby Betsy' (pink with yellow eye)

'Little Grapette' (reddish purple)

'Lullaby Baby' (soft peach)

'Mini Pearl' (peach).

In recent years several hybrids derived from ‘Squeaky’ have been introduced into the breeding programme including being used in sibling crosses.

Canna

By the early 1980s large numbers of *Canna* cultivars were collected and trialled at ABG. Many showed symptoms of virus infection such as vein clearing and stunted growth and some developed bacterial soft rot (*Pectobacterium carotovorum*) which was considered likely to be secondary to the virus infection. The worst affected cultivars were culled, and those that remained were evaluated over several years, with the best performers being included in our display gardens.

Subsequently a *Canna* breeding programme was instigated at ABG to produce virus-free cultivars that performed well as garden subjects. Seed from seven high-performing healthy cultivars was sown on 4 May 1987 in a heated greenhouse with timed lighting providing 16 hours light per day. The resulting seedlings were planted in trial beds in early October 1987.

Seed of *Canna* ‘Cupid’ was sown on 17 May 1988 with resultant seedlings planted in the trial ground on 13 October 1988.

On 16 June 1988, the following pairs of cultivars were planted to act as parent blocks with the objective of producing new virus-free cultivars in the main colour range groups:

- red-flowered pair: *C.* ‘America’ (no seed produced) and *C.* ‘Assault’
- pink-flowered pair: *C.* ‘Cupid’ and *C.* ‘La Boheme’
- yellow-flowered pair: *C.* ‘Banner’ and *C.* ‘Felix Ragout’.

Seed was sown on 26 May 1989, and the resultant seedlings planted out on 10 October 1989. Seedlings that demonstrated desirable characteristics and high performance were initially given a code. Seedlings that did not reach the required standards were culled.

ABG trialled *Canna* cultivars from 2017–2020 including those available on the market, with ABG-bred selections as a comparison.

Each *Canna* was given an overall rating according to ABG star performer criteria (1 = poor performer to 10 = excellent performer). Cultivars that scored 8 or more were considered top performers and are recommended for Auckland based on the results of these trials. Overall ratings took into consideration flowering period, quality of flowers, absence of pests and diseases, habit and vigour. ‘Gabriel’ (coral pink) received the highest rating and is promoted as a Star Performer. ‘Hampton’ was named in 2019 by Emma Simpkins and plants have been made available to the market.

Camellia

ABG holds an extensive collection of some 500 different camellias including around 60 species. When camellia flower blight (*Ciborinia camelliae*) arrived ABG initiated a breeding programme to develop attractive garden hybrids resistant to this debilitating disease. The first crosses were made in 2015. The aim is to also produce seedlings with handsome glossy foliage and attractive flowers (preferably scented) over long flowering periods.

Matt Denton-Giles (Massey University) tested 39 *Camellia* species in the ABG collection for susceptibility to camel-

lia flower blight and in 2013 reported variable degrees of susceptibility, with *C. lutchuensis*, *C. transnokoensis*, *C. yunnanensis* and *C. yuhsienensis* as having flower blight resistance. *C. lutchuensis* and *C. transnokoensis* have been primarily used in the ABG breeding programme, *C. yunnanensis* has been used sparingly. To inform the genetic compatibility of planned crosses the chromosome counts of these species were researched: *C. yunnanensis* ($2n = 30$), *C. lutchuensis* ($2n = 30$), *C. transnokoensis* ($2n = 90$)

The selected species were initially crossed mainly with a selection of larger-flowered japonicas and reticulata hybrids identified as being petal blight resistant. Parents used in recent times include 'Wild-fire', 'Bob Hope', 'Fairy Blush' 'Transpink' and 'Transtasman'.

Seedlings are currently being grown in field trials to ascertain their suitability of gardens and subsequent commercial production.

SUMMARY

The primary aim of ABG breeding programmes has been developing disease-resistant garden plants through breeding for genetic resistance. This aligns with ABG's pesticide minimisation programme that precludes the use of pesticides on ornamental

plants. Although emphasis is on developing outstanding garden subjects, increasingly the priority is also placed on commercially viable hybrids. The *Hemerocallis* and *Camellia* programmes are currently active at ABG, the latter being a particularly long-term project. Active breeding of *Canna* is not currently undertaken at ABG. The *Veronica* programme has resumed in recent years on my own property.

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