Plant breeding at Auckland Botanic Gardens©

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INTRODUCTION

Auckland Botanic Gardens (ABG) has a long history of plant breeding. It is best known for developing the 'Wiri' series of *Hebe* and *Leptospermum*, and has worked collaboratively with Dr. Keith Hammett on crops including *Dahlia*.

The stated objective of ABG is to 'Engage people with plants and gardens.' To this end it actively promotes sustainable gardening practices including recommending plants suitable for Auckland conditions, and we practice and advocate a minimal spray regime.

ABG promotes plants that perform to a high standard in Auckland conditions without applications of insecticides and fungicides. Trials are undertaken to ascertain the best performing plants according to criteria that includes flowering periods, foliage and habit, and general plant health. The very best of the are labelled "Star Performers", and these are featured in display gardens and promoted to the public on the ABG website, social media, printed material and on plant labels.

Many popular groups of garden plants include numerous cultivars that were not primarily bred for garden performance. Some such as dahlias, camellias, daffodils, chrysanthemums, and many others were bred to produce exhibition quality flowers for the show bench. Numerous ornamental commercial crops have been bred to produce flowers on young compact plants that have high aesthetic appeal at point of sale. This is an understandable commercial imperative, but it does not necessarily result in plants that perform well in gardens. In fact it often diminishes garden performance as evidence by popular crops such as many compact perennials and precocious annuals that are flowering when purchased but not for much longer.

The reason ABG breeds plants is to fill some of the gaps that commercial and amateur plant breeders do not cover. The primary ABG priority is always to produce attractive ornamental plants of outstanding garden performance with particular focus on high health.

BREEDING PROGRAMMES

Hemerocallis

1. Objective.

The ABG daylily breeding programme aims to develop rust resistant, evergreen daylilies with long flowering periods in a range of flower colours and with attractive foliage. They must require little maintenance and make effective ground covers.

2. Background.

This breeding programme is a direct result of the devastating impact daylily rust (*Puccinia hemerocallidis*) had on many popular cultivars when it arrived in New Zealand. This included decimating many of the best performing cultivars identified over more than 20 years of trials at ABG.

Although many cherished daylilies became unsightly overnight, a few showed little or no effect from the new incursion. ABG has continued to trial daylilies with emphasis on plant health, and in 2015 published an updated list of recommended cultivars.

The breeding programme was initiated in 2014 and has been led by Jack Hobbs and Emma Bodley, with support from Nikita Engels (2015), Keely Paler (2016), Mere Brewer (Senior Gardener Plant Collections), and ABG propagator Billie Elliot.

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3. Description.

The daylily breeding programme is based on using rust resistant cultivars. The main parent used to date has been *H.* 'Squeaky', an evergreen cultivar with attractive narrow arching foliage and relatively small yellow flowers throughout most of summer. Although the flowers are less flamboyant than those of many cultivars, it remains an exceptional garden subject with its dense spreading habit making it an effective groundcover.

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.

In the summer of 2016/17 *H.* 'Squeaky' was mainly pollinated with *H.* 'Oriental Ruby', *H.* 'Cade Stewart', *H.* 'Zella' and *H.* hybrid 2.

Other pollen recipients were, *H.* 'Oriental Ruby', *H.* 'Cade Stewart, *H.* hybrid 2, *H.* hybrid 24 (pollinated with hybrid 2 and 'Zella'), *H.* 'Zella' (pollinated with hybrid 24), and hybrid 22 (pollinated with 'Cade Stewart').

Pollination is mainly undertaken in the afternoon when it is warmer and abundant pollen is available. Seed is collected once the fruit is plump and immediately it is beginning to turn brown. The seed is stored until all seed is collected. The ABG nursery germinates and grows the seedlings which are planted into trial beds.

The first batch of seed was sown in autumn 2015 and placed under grow lamps that extended the day length to around 16 hours. This worked well with all seedlings growing vigorously through the winter months including those that when mature turned out to be deciduous. The balance of seed was sown in spring.

To date three *H.* 'Squeaky' hybrids have been selected that meet our criteria:

- Hybrid 2: Lemon-yellow flowers with hint of green in throat, evergreen (Figure 1).
- Hybrid 22: Purplish flowers, healthiest in this colour range.
- Hybrid 24: Gold flowers, attractive dark green foliage (Figure 2).

In 2017/18 it is planned to increase the use of *H.* 'Squeaky' hybrids in the breeding programme including undertaking sibling crosses.

Figure 1. Hybrid 2.

Figure 2. Hybrid 24.

Camellia breeding

1. Objective.

The ABG camellia breeding programme aims to develop a range of attractive garden hybrids resistant to camellia flower blight caused by the fungus *Ciborinia camelliae*. Desirable characteristics include handsome glossy foliage, attractive flowers (in a range of sizes but larger than *Camellia transnokoensis* and *C. lutchuensis* flowers), and they must be resistant to flower blight. Additional desirable characteristics include long flowering periods, blooms that drop cleanly way when spent, and attractive colourful new growth. Scented blooms are a bonus. Small to medium sized trees of slender habit have particular value in small gardens and containers.

The process involves crossing petal blight resistant species (mainly *C. lutchuensis* and *C. transnokoensis)* with a selection of larger flowered hybrids such as japonicas and reticulatas.

The hypothesis is that crossing petal-blight resistant *Camellia* species with large flowered cultivars will produce ornamental hybrids with increased disease resistance. Over time it should be possible to increase the flower size and colour range of disease resistant cultivars and restore the status of camellias as first rate garden plants.

2. Background.

The fungus *C. camelliae* rapidly spread throughout New Zealand following its accidental introduction in the early 1990s. It infects the blooms of many ornamental camellias, notably spring flowering cultivars, causing them to turn brown and fall early.

Field surveys of cultivars susceptible to camellia petal blight conducted during spring 2016 at ABG confirmed 190 camellias infected with petal blight. The total number is likely to be much higher as many cultivars were not flowering during the survey period and will be re-surveyed.

There are 500 *Camellia* species and cultivars in the ABG Camellia Garden, including 60 species. This extensive collection has significant educational and conservation value, and some species have considerable ornamental value.

Following the introduction of camellia flower blight into New Zealand, Matt Denton-Giles (Massey University) tested 39 camellia species in the ABG collection for susceptibility to Camellia flower blight and found variable degrees of susceptibility (Denton-Giles et al., 2013).

This research identified four species as having flower blight resistance: *C. lutchuensis* (Figure 3), *C. transnokoensis* (Figure 4), *C. yunnanensis,* and *C. yuhsienensis*. The first three species are primarily being used in the ABG breeding programme.

Figure 3. *Camellia lutchuensis*.

Figure 4. *Camellia transnokoensis*.

In 2015 the Auckland Branch of the New Zealand Camellia Society and the Friends of the Auckland Botanic Gardens established the Neville Haydon Fund to assist with the breeding of petal blight resistant ornamental camellias.

Neville Haydon was the driving force behind the establishment of the Camellia Garden in 1985, donating most of the plants and advising on the layout of the plantings. He also donated most of the species camellias in our collection.

The first crosses were made in 2015 but produced few seedlings. This was partly due to some selected parents proving infertile. Subsequently more vigilant observation of the reproductive capacity of potential parents was undertaken before finalising breeding programmes.

The ABG breeding project has been led by Rebecca Stanley (Curator) and Emma Bodley (Botanical Records & Conservation). Support has been provided by Billie Elliot (Propagator), Mark Fielder (Collection Curator Magnolias & Camellias), and Jack Hobbs (Manager). Neville Haydon, former proprietor of Camellia Haven, has been an invaluable source of information and plant material. Matt Denton-Giles has also provided advice and information. Students contracted to undertake the pollination and recording of crosses have

been Jess Ryder (2015), Keely Paler (2016) and Matthew Savage (2017).

3. Description.

The first step was to identify flower blight resistant species and cultivars (mainly *C. japonica* and *C. reticulata*) for use in the breeding programme. *Camellia lutchuensis* and *C. transnokoensis* have been the main species used as parents, *C. yunnanensis* has been sparingly used and *C. yuhsienensis* has not yet been used.

Surveys were then undertaken to ascertain the relative petal blight resistant of *C. japonica* and *C. reticulata* cultivars. Cultivars resistant to petal blight were subsequently surveyed to identify those that set viable seed to inform planning of future crosses.

Breeding plans were then prepared that considered using parents with compatible chromosome numbers which is critical to informing genetically compatible crosses.

Camellia japonica consists of diploid (2*n*=30) and triploid (2*n*=45) cultivars. Many of the *C. japonica* cultivars originally selected as potentially useful parents have not set seed.

Camellia reticulata (2*n*=90) cultivars have been used sparingly in the breeding programme. However autumn flowering camellias such as *C. sasanqua* (2*n*=90) cultivars have not been included in the programme as they mainly escape blight by being early flowering, and also the flowers shatter fairly quickly when spent. Therefore they remain fine garden subjects with many cultivars widely available. However some hybrids such as *C. sasanqua* × *C. fraterna* 'Yoimachi' have been included.

Camellia transnokoensis × *C. lutchuensis* 'Transluscent' is of particular interest as a parent being a cross (by John Lesnie) of the two most resistant species, *C. transnokoensis* (2*n*=90) and *C. lutchuensis* (2*n*=30). Therefore *C.* 'Transluscent' should have a chromosome count of (2*n*=60), making it a good fit with hybrids between *C. reticulata* and *C. japonica* which should also have a chromosome count of (2*n*=60).

Camellia 'Transpink' (Figure 5) is a *C. transnokoensis* hybrid raised by Neville Haydon that he believes should have a chromosome count of (2*n*=60). It sets seeds and should be compatible with diploid *C. japonica* cultivars (2*n*=30).

Figure 5. *Camellia* 'Transpink'.

Species camellias chromosome counts:

- *C. yunnanensis* (2*n*=30)
- *C. lutchuensis* (2*n*=30)
- *C. transnokoensis* (2*n*=90)
- *C. yuhsiensis* (2*n*=45, 75, and 90)

Hand pollination is undertaken by students both ways when possible (i.e., where both

potential parents set seed and produce pollen). The flowers of pollen recipients are emasculated prior to pollination. Different coloured pipe cleaners are used to identify different pollinators.

Pollen of donor plants is often stored in refrigerators so it can be applied to the recipient plant when receptive.

Students complete field data collection sheets that include recipient and donor name, bed location, number of flowers pollinated and date of pollination.

Mesh bags are placed over all visible fruit to collect seed as it ripens and prevent it being lost. Seeds are germinated and grown in the ABG nursery and accessioned to ensure records are kept in the ABG database. Seedlings are planted at ABG. They should flower approximately after 18 months which will enable identification of resistance early on and discarding of any susceptible to petal blight.

SUMMARY

Developing disease resistant garden plants through breeding for genetic resistance aligns with ABG's pesticide minimisation programme that precludes the use of pesticides on ornamental plants.

As anticipated the *Hemerocallis* breeding programme is producing promising offspring more quickly than the *Camellia* breeding programme. However it will be a few more years before the first new daylily cultivars arrive in the market. The *Camellia* breeding programme is a much longer term project.

Literature cited

Denton-Giles, M., Bradshaw, R.E., and Dijkwel, P.P. (2013). *Ciborinia camelliae* (Sclerotiniaceae) induces variable plant resistance responses in selected species of *Camellia.* Phytopathology *103* (*7*), 725–732 https://doi.org/10.1094/PHYTO-11-12-0289-R. PubMed

Additional reading

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Jiyin, G., Parks, C.R., and Yueqiang, D. (2005). Collected Species of the Genus *Camellia* an Illustrated Outline (China: Zhejiang Science and Technology Publishing House).