Breeding and Developing New Australian Plant Varieties©

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INTRODUCTION

The flora of Australia is one of the most diverse and floristically spectacular in the world with estimates of more than 20,000 species (Chapman, 2009), many of which are adapted to drought and soils with poor nutrients. The diversity of genera and species is well recognised, less so is the great diversity within species.

Much of the Australian continent is semi-arid to arid or with long periods where there is little or no rain. In Western Australia the climate is undergoing a sustained period of drying while average temperatures are increasing (Fig. 1), which has a number of implications including a reduction in the amount and frequency of watering allowed for home and public gardens, and landscapes.

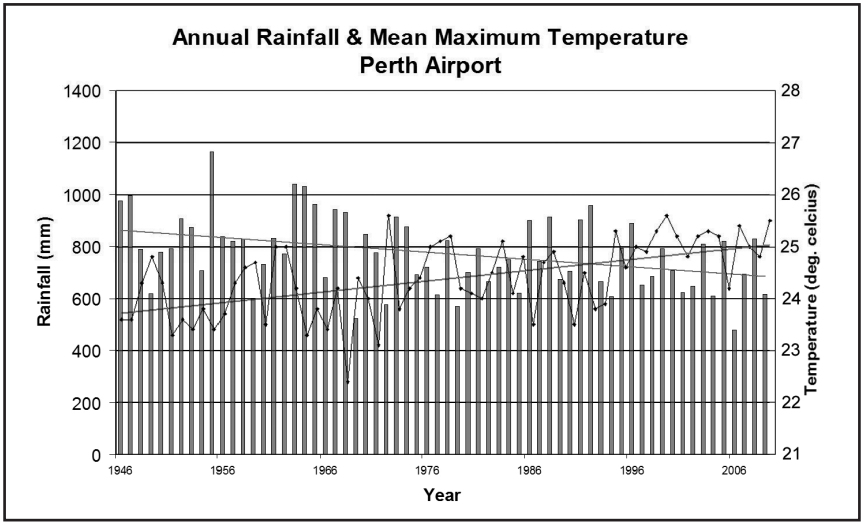

Figure 1. Annual rainfall data 1946–2009 (Department of the Environment, Water, Heritage and the Arts, 2010).

The combination of diversity, floristic impact, and efficient water and nutrient use is the most important strategic advantage for the Kings Park and Botanic Garden (KPBG) breeding program, particularly when intraspecific diversity is taken into account.

The Australian flora is generally horticulturally unimproved and many highly ornamental species are difficult to cultivate with traditional systems due to their specialised growing requirements. There are opportunities to improve the quality and presentation of species and varieties of this flora so that they are more adaptable to cultivation and more acceptable to the wider population.

DISCUSSION

The aim of the plant breeding and development program at Kings Park is to develop new Australian native plants that are site and climate adaptable, have a range of desirable horticultural characteristics, and can be grown more widely in home gardens and public landscapes. The program also has the potential to provide a long-term royalty stream through marketing superior plant varieties in partnership with leading ornamental plant producers locally, nationally, and internationally.

A number of local native plant genera have been identified as having the attributes required to successfully develop new cultivars suitable for marketing as landscape and garden plants and/or flowering pots. The attributes considered when selecting these genera included:

- Significant genetic variability.
- Site and climate adaptable.
- Low water and nutrient requirements.
- Attractive leaf and flower presentation.
- Capacity to extend the colour palette and flowering season.
- The potential to produce new varieties with compact forms.
- Ease of propagation.
- Likely market acceptance.

Plant groups currently targeted include *Grevillea*, the Haemodoraceae (including *Anigozanthos, Conostylis,* and *Macropidia*), the Goodeniaceae (especially *Scaevola* and *Leschenaultia*), and the small myrtles (including *Darwinia, Chamelaucium, Hypocalymma,* and *Verticordia*).

Kings Park and Botanic Garden has developed a model for the breeding and commercialisation of these plant groups that is underpinned by sophisticated collection programs using global positioning system (GPS) and geographic information system (GIS) and real-time mapping technologies, controlled glasshouse environments, and advanced scientific techniques using DNA analysis and plant tissue culture protocols.

A critical component of the model is the identification of commercial partners to fund these programs in exchange for the right to commercialise varieties produced under the programs. Kings Park and Botanic Garden has successfully funded the *Scaevola, Grevillea,* and small myrtles programs in this manner, and delivered a path to market that could not be achieved using solely its own resources. The success of this strategy is underscored by the 2010 international commercial release of the KPBG-bred hybrid, *Scaevola* 'Blue Print' by Ball Flora.

Other benefits of the breeding and development program include the expansion of infrastructure such as glasshouses and nursery areas, increasing specialised skills of staff, and the development of a dedicated volunteer program.

There are three main technical strategies that deliver new varieties. These are selection, controlled pollination, and biotechnical methods. The DNA analysis is used to confirm the existence of hybrids.

- **Selection.** Selection of plants with superior characteristics forms a significant part of the KPBG breeding strategy to deliver varieties that can have immediate market impact, and to provide better parents for targeted breeding strategies.

- **Controlled Pollination.** This is the main method for producing new varieties, and uses a range of technological aids such as pollen storage, environment modifications to induce flowering, specialised plant tissue culture techniques (including early embryo rescue), polyploid induction, seed x-ray, and DNA analysis for early detection of hybrids. Controlled pollination is likely to remain the main technique for new hybrid production in the medium term, particularly as induced polyploids with restored fertility become available. Greater use of backcrossing (particularly with hybrids with low fertility) and sibling crossing will deliver more variation in second and later generation hybrids, allowing greater choice for the commercial partners.
- **Biotechnology.** A small but significant project on somatic fusion between *Scaevola* and *Leschenaultia* has in 12 months delivered most of the protocols for producing protoplasts of *S. aemula* and *Leschenaultia* 'Lola', and regenerating these to the macro-calli stage. Initial attempts to fuse the protoplasts using polyethylene glycol failed due to toxic effects. Electrical fusion could not be attempted due to lack of access to the necessary equipment. Protoplasts of two taxa of *Grevillea* were also produced, underscoring the potential usefulness of this technique on a range of plant species.

GOODENIACEAE

Kings Park and Botanic Garden produced a range of interspecific *Leschenaultia* hybrids in the 1990s, eight of which were commercially released in Australia in 2000. They were trialled internationally, but were not released due to issues with *Botrytis* infection in conditions of high humidity.

Breeding within *Scaevola* has been underway since 2005 following an expression of interest process to identify commercial partners interested in partly funding the activity. Ball Australia, and its parent company, Ball Flora in the U.S.A. agreed to provide funds, and over the period 2005 to 2008 over 600 hybrids were sent for trialling. In 2010 Ball Flora released the first hybrid from this program, *S. aemula* 'Blue Print' in several international markets. Several others remain under trial.

HAEMODORACEAE

The main breeding activity in this family has been with *Anigozanthos,* which has been underway since 2008, although there was some activity in the 1970s. The 11 species of *Anigozanthos* are endemic to Western Australia and the red and green kangaroo paw, *A. manglesii*, is the floral emblem of Western Australia.

The current strategy for the *Anigozanthos* breeding program is to produce disease-resistant, long-flowering, compact varieties in a range of colours, and similar hybrids with flowering stems to 1 metre.

The black and green kangaroo paw, *Macropidia fuliginosa*, is related to *Anigozanthos* and there has been interest over the years in hybridising the two genera, but without success. Kings Park and Botanic Garden aims to examine the option of using somatic fusion to hybridise these two genera. There has been no crossing activity with *Conostylis* as yet. Many of the species have been collected and grown, and assessments and selections will begin in 2010.

A selection of *A. rufus* with iridescent orange flowers named 'Kings Park Federation Flame' was released in 2001 through the Friends of Kings Park as the Western Australian floral selection for the Centenary of Federation. Ramm Botanicals Pty Ltd gained the broader commercialisation rights through an expression of interest process and has released this cultivar in Australia in 2010, with an international release planned for 2011.

SMALL MYRTLES

The main focus of this breeding activity is selection of variants from wild populations, with some work in controlled hybridisation. Several new forms of *Hypocalymma* species have been collected, including a chance hybrid between *H. robustum* and *H. angustifolium*, as well as an upright form of *H. xanthopetalum* which grows to a metre tall.

A number of selections of *Chamelaucium floriferum* have been made, including a pure white form, and some that are compact. Robust populations of *C. megalopetalum* have been targeted, to combine with compact and unusual forms of *C. uncinatum*. The genetic range of *C. ciliatum* has been collected, including summer-flowering varieties. Some intergeneric hybridisation with *Verticordia* has been attempted, thus far without success.

Research into hybridising robust species of *Darwinia* with the "bell-flowered" species from the Stirling Range started in 2009, with a number of putative hybrids now germinated in culture. These will be deflasked in 2010, and evaluated for a range of attributes.

GREVILLEA

The *Grevillea* breeding activity has been underway since 2007. *Grevillea* has 340 species, a geographical and climate range covering most of Australia, from the tropics to alpine areas to deserts, and has significant diversity of flower colour, flower size, flowering season, flower presentation, and plant and leaf morphology.

The current strategy for the *Grevillea* breeding program is to produce hardy, free-flowering plants in a range of colours that are suitable for home gardens and broad landscaping. A major component of this strategy is to hybridise Western Australian species from the semi-arid and arid zones with those from the north and eastern parts of Australia, with subtropical and tropical climates. A number of these hybrids are now undergoing evaluation.

RESTORING FERTILITY

Many hybrids produced in the programs above are either sterile, or have very low fertility. Restoring fertility to enable recombination of the range of attributes from the original parents is a major focus of the breeding program. To date backcrosses have been produced from several hybrids with low fertility, which will be evaluated once they have flowered.

Where the hybrids are completely sterile, a program to induce increased ploidy level has been developed. Plant material is treated using the compound oryzalin either on germinating seedlings, in tissue culture, or on the stems of mature plants. Treated material will be evaluated using flow cytometry to determine whether the treatments have been successful in inducing increased ploidy. To date oryzalin seed treatment of some *Anigozanthos* hybrids have been successful in producing tetraploids.

Research has also commenced on early embryo rescue, to determine whether hybrid seed can be germinated in vitro if harvested prior to maturity. If successful this technique may enable seed from wide crosses to be rescued prior to aborting on the plant.

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