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DO EUCALYPTS HAVE A PLACE IN THE URBAN FOREST OF TODAY AND TOMORROW?

How can we make this iconic Australian tree genus into a happy suburbanite? Are 'designer trees' the answer?

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Introduction

The Eucalypts (genera Eucalyptus, Corymbia and Angophora) contain unique flora with over 700 species found throughout Australia (and its closest northern neighbours) and represent one of Australia's greatest floral ic ons. Eucalypts play a vital role in all Australia's ecosystems providing habitat for native birds, insects and a nimals. There are a great number of species that are seldom seen in cultivation, with ornamental flowers, leaves, buds, and fruit.

The majority of eucalypts available in the Australian nursery sector are grown from seed, with a small number of grafted varieties mainly from the Corymbia genus. Breeding and development programs will enable a wider range of ornamental eucalypts to become available to the Australian nursery and garden sector, with "desig n" of new hybrids and selection of superior forms. All selected forms must be clonally propagated to ensure genetic integrity, however, clonal propagation (including cutting production, grafting and tissue culture) is difficult in most eucalypts and can be genotype dependant. As published research to date has focused on a limited number of eucalypts, there exists a large gap in knowledge as to how the majority of ornamental species will respond to clonal propagation.

How can we make this iconic Australian tree genus into a happy suburbanite? Are 'designer trees' the answer?

This paper will discuss the University of Adelaide's Ornamental Eucalypt Development Program, what we hav e done, what we are doing, why we are doing it and what we will do in the future, to address these questions.

An example of a long term breeding program with lots of collaboration, funding, hard work and passion, that is starting to bear fruit.

The University of Adelaide's Ornamental Eucalypt Development Program (OEDP) commenced in 1996 with Ph D research by Dr Kate Delaporte. Her PhD studies looked at aspects of the development of eucalypts for ornamental horticulture, and generated hundreds of interspecific hybrids. These hybrids were planted in the Laidlaw Plantation, a two hectare site at Urrbrae, South Australia, which now contains over 800 putative hybrid eucalypt genotypes, as well as around 350 individuals from 30 different species planted for breeding purposes, and is a significant germplasm resource for the OEDP.

Research and development of ornamental eucalypts continued from 2000, with projects funded by RIRDC (Publication No 04/125, No 08/018 and No 12/120), the Playford Memorial Trust, with additional support from the Laidlaw Family, the Frank and Hilda Perry Trust and the SA State Government.

The RIRDC funded programs sought to breed and select superior forms for further development, They focussed on breeding new varieties for the Australian cut flower market, investigation of the selected lines for their suitability for cut flower production (vase life assessments), propagation (trials including cutting propagation and grafting) and general production capabilities. The general criteria for cut flower varieties include desirable flower colour and presentation, floriferousness, tree architecture, response to production methods and economic propagation.

During that time, Humphris Nursery teamed up with the OEDP to undertake investigations into the top 10 selections for suitability for propagation by grafting. This required an examination of potential rootstock species and grafting methods, as the OEDP varieties at that time were from the Symphyomyrtus Bisectaria group of eucalypts, and far different from the Corymbia types then available. The selection process was long and difficult, but yielded results in 2012 with the first release of two OEDP varieties, Nullarbor Lime and Nullarbor Rose. These two varieties are derived from crosses between dry land species from Western Australia, E. macrocarpa, E. pyriformis and E. youngiana, and have retained the glaucous wax of the male parent E. macrocarpa and the more upright habits of the female parents. The varieties are grafted onto selected seed grown rootstocks to make them more adaptable to a range of climates and soil types. It has been a slow and expensive process, with 5 years of research and development to find the best rootstock and grafting conditions.

All reports from these projects can be sourced from RIRDC (http://www.rirdc.gov.au/publications).

More recently, from 2010-2013, Horticulture Australia Pty Ltd and three Australian Nurseries provided support for the OEDP to gather base line knowledge about ornamental eucalypts, to underpin further development (Project NY09023).

The HAL Project investigated the reproductive biology of eucalypts and aimed to optimise propagation methods to enable a future eucalypt breeding programme. The partners in this project were Yuruga Nursery (Walkamin, FNQ) to investigate tissue culture, Narromine Transplants (Narromine, NSW) to investigate cutting production, and Humphris Nursery (Mooroolbark, VIC) to investigate grafting.

A number of gaps in the knowledge base underpinning the development of ornamental eucalypts for horticulture were identified. Very little information exists on the relationship between climate and reproductive development, and also very little information on stigma receptivity and pollen viability for any species outside of the forestry industry. Over 100 individual plants from 42 species and eight hybrid populations were used during this study. All plants are located at the Waite Campus, Laidlaw Plantation, or the Waite Arboretum, Urrbrae, South Australia.

This project sought to address some of the gaps by investigating aspects of reproductive biology, phenology, and clonal propagation:

1. How well does pollen of these species survive in storage, and what temperatures are optimal for pollen germination? Results indicate that pollen remains viable after storage, but viability decreases from 70% (2 years storage) to 40% (10 years storage); pollen will germinate well between 10-35°C, and will remain viable after storage for 21 days between 10 and 35°C.

2. How many days after anthesis (cap fall and pollen shed) do the stigmas become receptive? Previous research suggests anywhere from 0 to 10 days, but what is it for ornamental species? Results were inconclusive; generally pollen applied 5 to 8 days after anthesis will produce the most seed, but it varies with species.

3. How does the phenology of a species/hybrid change and how do flower buds develop, and is there an effect of environmental conditions, such as temperature, day length or rainfall, on the timing of flowering? Phenology charts were produced for most of the species and hybrids within this trial, however, with only 2 and a half years to gather data, significant correlations between climate and phenology were not found. The study needs many more years' worth of data, and a wider range of species and locations before a true picture will emerge (but it is important to start somewhere!).

4. What is the effect of flower size and genetic relatedness on "crossability"? If we cross E. macrocarpa with C. ficifolia, what are the chances that will produce viable seed? And what about the actual technique - can we use the methods developed by the forestry industry to make pollinations more efficient? This part of the program crossed many different species, with different size flowers, and compared the two most often used techniques – classical pollination and the "One Stop Pollination" method. The likelihood of seed being produced was dependant on flower size, genetic relatedness and technique, and varied considerably between species. While close crosses generally produced seed, of particular note are the successful intergeneric crosses between Corymbia species and Eucalyptus species. Seed was produced from crosses between C. calophylla x C. ficifolia (genus Corymbia) and E. miniata (genus Eucalyptus subgenus Eudesmia), C. citriodora and E. rhodantha (genus Eucalyptus subgenus Symphyomyrtus), C. citriodora and E. miniata (genus Eucalyptus subgenus Eudesmia), and E. conveniens x

E. tetragona (genus Eucalyptus subgenus Eudesmia) with C. ficifolia (genus Corymbia), however this seed has not yet been germinated.

5. Can ornamental eucalypts be propagated clonally in an economic and reliable way? The Project partners investigated grafting, cuttings and tissue culture. In brief, propagation by grafting and cuttings showed limited success, while propagation by tissue culture was highly successful for particular lines

Grafting identified ongoing issues with scion:rootstock combination incompatibility, rootstock variability (clonal rootstocks produced through tissue culture may alleviate this issue), pre- and post- graft environmental conditions, scion size and maturity, and the time and expense of producing plants through grafting.

Cutting propagation was investigated by cuttings derived from mature trees (coppice) and from seedlings. Eucalypts are extremely difficult to propagate by cuttings, it is highly genotype and maturity dependant. Some success was achieved, but results were very dependent on maturity of tissue and the genotype.

Propagation via tissue culture was successfully achieved, essentially using micro cutting methods developed from the forestry industry, where lines are established in culture from seed. This proved highly successful, with good initiation and multiplication from MOST seeds. Rooting and de-flasking proved much more difficult, and establishment even harder. Every step is genotype dependant and requires investigation to determine optimal conditions. Corymbia seed lines where much more suited to the tissue culture methods used than the Symphyomyrtus Bisectaria lines. Differences in optimal methods are apparent at all stages of the process, including the media & conditions needed for multiplication and rooting, and for deflasking and establishment.

The other problem encountered with tissue culture is selection. If the plants are initiated into culture from seed, how do we select them for their ornamental characteristics? The first selection step is the actual initiation in culture – the line must multiply, root and survive acclimatisation in sufficient numbers to be economically viable. Then, plants are set out to field trials to wait for flowering. This is most likely to take 5 years from seed, and for that whole time the lines must be maintained in tissue culture, with regular subculturing to maintain the health of the plantlets. If you are very lucky, you might get a line that flowers early, say, within 2 and a half years from seed. And it might have a flower colour that you are looking for. And it might have a habit that is desirable for home gardens and urban forestry. This is when you would need to start large scale field trials, in pots and in ground, to more thoroughly determine the characters of the new variety and make sure it is stable.

The OEDP and collaborators are very happy to say that they were lucky that such a line was found, and we are progressing this little wonder plant through the field testing process as we speak.

The full report from this project is available from Horticulture Australia Ltd (http://www.horticulture.com.au/)

But what has all this got to do with ‘Designer Trees’ and eucalypts in suburbia?

In Australia, our external environment is full of eucalypts. In the country areas, there are areas of remnant native vegetation, mixing with farmland with planted trees, some endemic, some from other parts of Australia. They are part of the landscape, and give a sense of place. In urban environments, the trees are fewer, and less comfortable in their surrounds. Often, they are majestic large trees, memories of a time prior to white settlement, but now causing conflicting emotions and opinions as humans try to reconcile a huge tree and its importance for habitat, air quality and human happiness with the problems of sheer size, water-seeking roots,
limb dropping, ‘messy’ flowers, and resident wildlife. Sometimes, the trees are the result of well-meaning Council planners and enthusiastic gardeners, planted 30-40 years ago, untried and untested, possibly with unrealistic expectations as to their growth and impact on the environment. These trees are now creating problems and ill feeling in the community.

Ironically, conversations along the lines of “we need to plant more eucalypt trees in our urban environment ” precede “My neighbour planted a eucalypt and it’s too big and its shading/dropping leaves on my garden ”. How can these conflicting opinions be reconciled? Are ‘designer trees’ the answer?

Take a set of characters that a tree should have: the height, the architecture, the canopy density, the vigour. Sometimes, the flower and leaf should be considered too. Now, look at all of the species (eucalypts in this case) and identify which species have what characters. Mix that with a good understanding of the relationships between species, the reproductive biology and genetic relatedness; develop a program to cross breed different species with desirable characters, and (hopefully) produce a new plant with the characters you want. For example, Corymbia maculata grows well in the eastern states, has a good upright habit, minimal limb drop (reportedly), but the bark, while attractive, is grey. C. aparrerinja on the other hand, has a glorious white trunk, but is a spreading tree from the sub tropics. Can the two be bred together, to result in an upright tree with a white trunk that grows well in most locations in Australia? In this case yes, however, the process of breeding new trees isn't quick; it can take 5-10 years to produce the new tree and road test it, and get it ready for wide spread use

It's easy to see that many of the trees, be they eucalypt or other, in our urban forests are in decline, or will be soon, from age, inappropriateness, climate change, disease. For example, the City of Melbourne Urban Forest Strategy 2012-2032 reports "Modelling shows that within the next ten years, 23% of our current tree population will be at the end of their useful lives and within twenty years this figure will have reached 39%." (City of Melbourne Urban Forest Strategy Revised Draft, September 2012).

These trees will need to be replaced, and the choice of what will be used to increase, renew and revitalise the Urban Forest across Australia becomes important. The same varieties and species that are currently planted could be planted again, or, we could look to a new generation of trees. Designer eucalypts could find an increased presence in our cities, and if they are more suited, planting them could take precedence over exotic species.

Armed with over 15 years of experience, the OEDP is about to embark on a new breeding program, to 'design' the 'right eucalypt for the right place'. We aim to develop a range of trees that are suitable to a range of climates, or for more specific ones; that have the shape, size, flowering, trunk colour, that is sought by designers; that will be disease resistant, low maintenance, non-invasive and 'safer'; that will increase city biodiversity and keep humans happy and healthy. It's a long term project and will not succeed without input from nurseries, advanced tree producers, landscape architects, councils and arborists, so expect to hear more from the OEDP soon.

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