Vase life characteristics of selected *Grevillea*

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Summary. *Grevillea* is a large genus containing many species, forms and hybrids bearing inflorescences with desirable cut flower characteristics. Nineteen different *Grevillea* spp. and forms (7), and 39 hybrids (including 11 repeat collections) were assessed for vase life. Longevity varied 3-fold, from 3 days for *G. wickhamii* to 9 days for a *G. whiteana* accession. Species with comparatively long vase lives included *G. pteridifolia*, *G. sessilis* and *G. whiteana*. These genotypes may be useful for cut flower production and/or in breeding programs aimed at producing new cut flower *Grevillea*.

Introduction

The *Grevillea* genus is comprised of 273 species, 61 subspecies or varieties, 2 formas, 3 unnamed taxa and about 150 cultivars (Wrigley and Fagg 1989). It is largely confined to Australia, there being only 5 species found exclusively outside Australia and 2 occurring in both Australia and Papua New Guinea. Wrigley and Fagg (1989) and Olde and Marriott (1994) present accounts of the *Grevillea* genus. These comprehensive works include descriptions of floral anatomy and morphology and present the related botanical terminology.

The ornamental potential of *Grevillea* as flowering landscape plants has been recognised. For example 'Robyn Gordon' is a well known and widely grown *G. banksii* x *G. bipinnatifida* hybrid (Costin and Costin 1988). Many *Grevillea* have prominently displayed (commonly terminal), large, colourful inflorescences. However, the cut flower potential of *Grevillea* is yet to be realised. Although the possibility of using *Grevillea* as cut flowers has been considered for some time (e.g. Costin and Costin 1988), little progress has been made commercially. Small quantities of *Grevillea* inflorescences are produced for use by local florists (e.g. in wedding bouquets) and for sale to florists via wholesalers at regional markets (e.g. Rocklea, Qld). Also, there is limited international trade in *Grevillea* cut flowers, most notably from Israel to The Netherlands (V. Wende pers. comm.).

It is thought that *Grevillea* have not been more widely grown for cut flower production because they have short vase lives. Vase lives of 3–4 days have been reported for mature inflorescences held in water (Lacey 1982; Vuthapanich *et al.* 1994). However, vase lives exceeding 1 week were recorded for 'Sandra Gordon' (Lacey 1982) and 'Majestic' (Vuthapanich *et al.* 1994) harvested and handled with a view to maximising longevity, i.e. at optimum harvest maturity and with the aid of vase solutions containing a biocide (e.g. 200 µL Physan-20/L), an acidifier (e.g. 320 mg citric acid/L) and sugar (e.g. 20–40 g sucrose/L) (Lacey 1982; Vuthapanich *et al.* 1994).

Data for 'Sandra Gordon' (Lacey 1982) and 'Majestic' (Vuthapanich *et al.* 1994) represent the few published accounts of vase life for *Grevillea*. Here, we investigate the possibility that other genotypes may have greater longevity. Vase life for a total of 58 accessions is reported. Nineteen different species and forms (7 forms), and 39 hybrids (including 11 repeat collections) were examined. Prominent among the accessions evaluated were subtropical *Grevillea* spp. and hybrids characterised by large, colourful terminal inflorescences, these being key elements for cut flower use.

Materials and methods

Seven successive vase life experiments were conducted during the spring (August–September) flowering period. The harvest dates and sources of *Grevillea* inflorescences in south-eastern Queensland and northern New South Wales were:

Experiment 1. 9 August 1994, P. Beal, Redlands Research Station, Cleveland.
Experiment 2. 16 August 1994, S. Spinks, Azalea Grove Nursery, Parkridge.
Experiment 3. 23 August 1994, E. Bunker, Redlands Greenhouses Holdings, Redland Bay.
Experiment 4. 29 August 1994, D. Mason, Hillfoot Nursery, Coraki.
Experiment 5. 6 September 1994, M. Hodge, Loganview Nursery, Logan Reserve.
Experiment 6. 13 September 1994, S. and R. Costin, Limpinwood Valley Nursery, Chillingham.
Experiment 7. 20 September 1994, A. Hansa, Fairhill Nursery, Yandina.

'Majestic' inflorescences from Redlands Research Station were included in each experiment as reference material. In-ground stock plants from which flowers were harvested varied in age from 1 to 7 years. Older plants were pruned regularly to encourage new flower-bearing growth. Only inflorescences judged to be normal in appearance and free of insect and/or disease damage were used in the vase life experiments.

Inflorescences of all accessions were harvested at similar stages of maturity, when the styles of the most advanced flowers were looped to the extent that they were judged ready for release from the perianth tube. A semicircular loop-like curvature of the style develops when the style lengthens during flower growth and development. The looped style, which includes basal superior ovaries, extends from the receptacle through a dorsal suture in the perianth tube (4 fused tepals) to outside the flower (Wrigley and Fagg 1989; Olde and Marriott 1994). It returns, in a U-bend, to be clasped at its swollen tip (pollen presenter and stigma) by the distal end of the perianth tube at the point where the anthers are borne. After anthesis, when the tip is freed, the loop largely disappears as the style straightens.

Foliage was removed from the stems at harvest. Inflorescences were packed between layers of damp newsprint in a polystyrene container. A layer of ice at the bottom of the container provided cooling. Flowers were taken to the laboratory in an air-conditioned car within 4 h of harvest.

Stem ends were recut under water to eliminate air entrapped in cut xylem ends and stems were placed in individual vases containing about 300 mL of 10 mg available chlorine [as dichloroisocyanurate, sodium salt (DICA)/L]. DICA was used to provide protection against microbial growth and associated plugging of the xylem.

Experiments were conducted in a controlled environment room (22°C, ≥70% relative humidity). Inflorescences were inspected daily. Vase life was judged subjectively as the time (days) until an inflorescence was no longer attractive; at this time inflorescences were individually rated (1, <5%; 2, 5–25%; and 3, >25% of inflorescence affected) for characteristics associated with loss of visual appeal. These characteristics were: flower abscission, perianth discolouration, inflorescence wilting, flower opening, and slippers. The term 'slippers' refers to the circumstance when the perianth tube separates from the receptacle but otherwise remains intact, clasping the distal end of the style (Wrigley and Fagg 1989). After the style has extended, the attached perianth tube resembles a ballet dancer's slipper. Slippers most commonly occur when the plant is under water stress or at high humidity (e.g. rainy periods), when there is delayed desiccation of the abscised perianth tube.

Replication (individual inflorescences) varied between 3- and 10-fold. Ten inflorescences at the prescribed maturity stage were not available for all genotypes. Vase life data were processed by analysis of variance (Genstat Release 2.2 software), for all experiments combined. Least significant difference values [l.s.d. ($P = 0.05$)] for comparison of means at minimum (3) and maximum (10) levels of replication are presented.

Results and discussion

Five characteristics were linked with end of vase life (Table 1): whole flowers abscised at the base of the pedicel from the raceme; perianth tubes discoloured in association with tepal abscission and senescence; inflorescences wilted as transpiration exceeded solution uptake from the vase; flowers opened, such that the looped style on many flowers lengthened and straightened (reflexed), creating an untidy appearance; and the occurrence of slippers as abscised, senescing perianth tubes clung to the stigma and pollen presenter region as the style reflexed, thereby contributing to the increasingly untidy appearance of the aging inflorescence. Abscission, discolouration, wilting, opening and slipper scores averaged over all accessions were 1.6, 2.1, 1.3, 1.8 and 1.1, respectively (Table 1). These data suggest that discolouration was the most important overall determinant of vase life. Slippers, on the other hand, were relatively and generally unimportant.

Vase life varied 3-fold, from 3 days for *G. wickhamii* to 9 days for a *G. whiteana* accession (Table 1). This range presents an opportunity for selecting suitable cut flower genotypes. For example, 'Honey Gem' has a vase life of 8 days and long (about 14 cm), terminal inflorescences bearing attractive orange–yellow flowers. The importance of standardising protocols for evaluation of postharvest longevity is evident from the significant differences revealed in this comparision of genotypes.

It is likely that vase lives reported herein could be further extended by the use of vase solutions similar to those described by Lacey (1982) and Vuthapanich *et al.* (1994).

The relatively large range in vase life suggests that one or more parents used in breeding cut flower *Grevillea* should be chosen from among the genotypes with comparatively long vase lives (e.g. *G. whiteana*) (Table 1). In this context, no *G. banksii* accessions had a longer vase life than 'Majestic' (6 days), the reference genotype. However, *G. banksii* hybrids with at least 3 other species, *G. pteridifolia*, *G. sessilis* and *G. whiteana*, had among the longest vase lives recorded ('Honey Gem', 'Pink Champagne' and 'Sylvia', respectively).

It is also apparent that breeding and selection for longer vase life should be extended to the F_2 and subsequent generations. Two *G. banksii* x *G. sessilis* F_1 hybrids ('Misty Pink', 'Piccolo Pink') had relatively short vase lives (Table 1). By comparison, the longevity of one of the parents, *G. sessilis*, and 2 F_2 selections ('Coopers Crossing', 'Pink Champagne') was extended.

The *Grevillea* accessions evaluated in the present study varied widely in colour (Table 1). No correlation between vase life and colour was evident. Colours of genotypes with relatively long vase lives (7–9 days; Table 1) included red ('Coopers Crossing'), pink ('Pink Champagne'), orange–yellow (*G. pteridifolia*), yellow ('Sandra Gordon') and cream (*G. whiteana*). Similarly,

Table 1. Mean vase life (days), in ascending order, of inflorescences of *Grevillea* accessions, associated numbers of replicates (individual inflorescences), the experiment number in which groups of accessions were assessed against the control genotype ('Majestic'), mean ratings (1, <5%; 2, 5–25%; and 3, >25% of inflorescence affected) over replicates for flower abscission (Absc), discolouration (Disc), wilting (Wilt), opening (Open) and slippers (Slip), parentage and generation of hybrids (as appropriate), and predominant perianth and style colour(s) of individual flowers on inflorescences

Genotype	Vase life[A]	No. of reps[A]	Expt. no.	Absc	Disc	Wilt	Open	Slip	Parents (generation)[B]	Perianth colour	Style colour
G. wickhamii	3.3	4	4	1.5	2.3	1.3	1.0	1.0	—	Yellow–orange	Orange
G. banksii f. *albiflora*	4.1	10	1	2.7	2.0	1.0	1.1	1.0	—	Cream–white	Cream–white
G. longistyla	4.3	10	5	1.2	2.6	1.1	2.1	1.0	—	Light–mid red	Light–mid red
'Crimson Yul-Lo'	4.9	10	3	2.0	2.0	1.0	2.7	1.0	(ban x ses) x ban (F_2)	Mid–dark red	Light–mid red
'Pink Parfait'	4.9	10	3	1.1	2.1	1.3	2.6	1.0	ban x ses (F_2)	Mid red	Light red
'Superb'	5.1	9	6	2.6	1.0	1.7	1.0	1.0	ban x bip (F_1)	Yellow–pink	Red–pink
'Starfire'	5.2	5	5	1.2	3.0	1.0	2.6	1.0	ban x pte (F_2)	Red–brown	Pink
'Ned Kelly'	5.2	10	6	2.7	1.1	1.4	1.0	1.0	ban x bip (F_1)	Pink–orange	Orange–pink
G. banksii (red/tree)[D]	5.3	4	7	2.5	2.8	1.0	1.3	1.0	—	Mid–dark red	Light red
'Majestic'	5.3	10	5	1.6	2.8	1.4	2.6	1.1	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Piccolo Pink'[C]	5.4	8	7	1.1	3.0	1.8	1.0	1.1	ban x ses (F_1)	Light–mid pink	Cream–pink
G. paradoxa	5.4	5	4	1.6	2.4	1.0	1.8	1.0	—	Pink–green	Light pink–purple
'Kay Williams'	5.5	10	7	1.0	2.5	2.7	1.0	1.0	(ses x pte) x ban	Yellow–pink	Cream
'Majestic'	5.6	10	3	1.7	2.4	1.0	2.0	2.4	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Majestic'	5.6	10	4	1.8	2.4	1.0	1.9	2.1	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Coconut Ice'	5.6	10	6	1.9	1.8	1.8	1.0	1.0	ban x bip (F_1)	Orange–pink	Mid–dark red
'Majestic'	5.6	10	7	1.4	3.0	1.0	1.0	1.2	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Jessie Morgan'	5.6	10	7	1.9	2.7	1.0	1.0	1.0	ban x ses (F_2)	Light pink	Light pink
'Majestic'	5.7	10	2	1.0	2.3	1.0	2.2	1.1	ban x whit (F_2)	Mid–dark red	Cream–yellow
G. banksii (red/tree)[A]	5.7	10	4	1.5	2.8	1.2	1.8	1.6	—	Mid–dark red	Light red
G. petrophiloides	5.7	4	4	2.0	1.0	1.0	1.3	1.0	—	Lavender–purple	White–lavender
'Majestic'	5.8	10	1	1.7	2.3	1.1	1.6	1.6	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Misty Pink'	5.8	10	3	2.1	2.0	1.1	2.5	1.0	ban x ses (F_1)	Mid–dark pink	Pink–cream
G. whiteana (seedling)	5.9	10	5	1.1	1.1	1.1	2.3	1.0	—	Cream	Cream
'Honey Wonder'	5.9	10	3	1.1	1.5	1.0	2.8	1.5	ban x pte (F_1)	Yellow–orange	Light yellow
'Majestic'	6.0	10	6	1.6	2.7	1.7	1.0	1.3	ban x whit (F_2)	Mid–dark red	Cream–yellow
'Golden Yul-Lo'	6.0	10	3	2.2	1.2	1.2	2.8	1.5	ses x pte (F_2)	Green–yellow	Mid yellow
G. caleyi x *aspleniifolia*	6.1	10	7	1.5	2.0	1.0	1.0	2.1	cal x asp (F_1)	White–lavender	Light purple
'Starfire'	6.1	10	6	1.0	2.4	2.0	1.0	1.0	ban x pte (F_2)	Red–brown	Pink
'Kay Williams'	6.2	5	6	1.0	2.6	1.4	2.2	1.0	(ses x pte) x ban	Yellow–pink	Cream
G. beadleana	6.2	10	7	1.8	2.7	1.0	1.0	1.0	—	Light red	Mid–dark red
'Kay Williams'	6.2	5	4	2.2	2.4	1.0	2.6	1.0	(ses x pte) x ban	Yellow–pink	Cream
'Pink Surprise'	6.4	10	1	2.6	1.0	1.0	1.8	1.0	ban x whi (F_1)	Light–mid pink	Cream–yellow
'Lime Green'	6.4	10	3	1.5	1.0	1.0	2.9	1.0	ses x pte (F_2)	Lime green	Light yellow
G. georgeana	6.4	5	4	1.0	2.6	2.0	1.4	1.0	—	Light red	Light red
'Elegance'	6.4	5	4	1.2	2.6	1.6	1.8	1.0	lon x joh (F_1)	Pink yellow–light pink	Mid red
G. flexuosa	6.4	5	4	1.2	2.0	1.0	1.8	1.0	—	Green–cream–yellow	Cream–yellow
'White Wine'	6.6	5	6	1.2	2.0	2.4	1.0	1.0	ban x ses (F_2)	Yellow–white	Yellow–white
'Caloundra Gem'	6.8	8	4	1.4	1.3	1.3	2.3	1.3	ban x whi (?)	Light pink–yellow	Cream
G. whiteana 'Coochin Hills'	6.8	5	4	1.8	1.2	1.4	1.6	1.0	—	Cream–yellow	Cream–yellow
G. whiteana 'Boondooma'	6.8	5	5	1.2	1.2	1.0	1.8	1.0	—	Yellow–cream	Yellow–cream
'Moonlight'	6.9	10	1	2.2	1.0	1.1	1.7	1.0	ban x whi (F_1)	Yellow–cream	Yellow–cream
'Sylvia'	6.9	10	3	1.5	1.0	1.0	1.9	1.0	ban x whi (F_2)	Mid–dark pink	Light–mid pink
'Sandra Gordon'	7.0	10	1	1.0	1.5	1.2	2.4	1.0	ses x pte (F_1)	Mid yellow	Mid yellow
'Caloundra Gem'	7.0	10	6	2.0	2.0	2.0	1.0	1.0	ban x whi (?)	Light pink–yellow	Cream
G. pteridifolia	7.0	3	7	1.0	2.3	2.7	1.0	1.0	—	Dark orange–yellow	Dark orange–yellow
'Coopers Crossing'[E]	7.1	10	2	2.4	1.9	1.0	1.8	1.2	ban x ses (F_2)	Mid–dark red	Mid–dark red
'Strawberry Blonde'	7.3	10	2	1.0	2.3	1.1	3.0	1.0	(ses x pte) x cal (F_2)	Pink–red	Light–mid yellow
G. caleyi x acanthifolia	7.3	10	7	1.0	2.7	1.3	1.0	1.0	cal x aca (F_1)	White–lavender	Purple
'Orange Marmalade'	7.4	10	2	1.0	2.4	1.8	3.0	1.0	ven x glo (F_1)	Yellow–orange	Dark red–black
G. pteridifolia	7.4	5	4	1.6	1.0	1.0	1.6	1.0	—	Dark orange–yellow	Dark orange–yellow
'Pink Champagne'	7.4	10	6	1.1	2.4	2.1	1.0	1.0	ban x ses (F_2)	Light pink	Light pink
G. sessilis	7.5	10	4	1.0	1.3	1.0	2.0	1.0	—	Yellow–cream	Cream–yellow
'Sylvia'	7.5	8	6	1.1	3.0	1.0	1.0	1.0	ban x whi (F_2)	Mid–dark pink	Llight–mid pink
'Honey Gem'	7.6	10	1	1.5	1.2	1.1	2.3	1.0	ban x pte (F_1)	Orange–yellow	Orange–yellow
G. whiteana 'Coochin Hills'	7.7	10	1	2.1	1.9	1.0	2.1	1.0	—	Brown–yellow–cream	Yellow–cream
G. venusta	7.9	7	2	1.0	2.4	1.9	2.7	1.0	—	Red–yellow–green	Black
G. whiteana	8.7	6	7	1.2	2.8	1.0	1.0	1.0	—	Cream	Cream

[A] l.s.d. ($P = 0.05$) for minimum replication = 1.5 days, and for maximum replication = 0.7 days.
[B] aca, *G. acanthifolia*; ban, *G. banksii*; bip, *G. bipinnatifida*; cal, *G. caleyi*, glo, *G. glossadenia*; joh, *G. johnsonii*; lon, *G. longistyla*; pte, *G. pteridifolia*; ses, *G. sessilis*; ven, *G. venusta*; and whi, *G. whiteana*. Sources of parentage information: Elliot and Jones (1990), O. Brown, E. Bunker, P. and E. Burt, G. Cooper, B. Dawson, A. Hansa, M. Hodge, R. and G. Norris, and G. Nosworthy, pers. comm.
[C] Syn 'Land Care'. [D] Red-flowered tree form. [E] Syn 'Spinks Red'.

colours of genotypes with relatively short vase lives (3–6 days; Table 1) included red ('Crimson Yu-Lo'), yellow–orange (*G. wickhamii*) and cream–white (*G. banksii* f. *albiflora*). Moreover, the closely related red *v.* white (cream) colour forms of *G. banksii* (Beal 1970) had comparable vase lives (about 5 days; Table 1).

Genotypes likely to be useful for cut flower production and/or for breeding to produce new genotypes for use in cut flower production have been identified. The vase life of 15 of the 58 *Grevillea* accessions examined met or exceeded our notional lower acceptable limit of 7 days. Selection of suitable genotypes, combined with harvest at optimum maturity and diligent postharvest treatment and handling, will underpin the development of the *Grevillea* cut flower industry. *Grevillea* inflorescences represent novel feature flowers, which are in demand on world markets.

Acknowledgments

Partial financial support by the Rural Industries Research and Development Corporation is acknowledged, as is advice and assistance from Dr Peter Jones, CSIRO Institute of Plant Production and Processing (Biometrics Unit). The cooperation and generosity of many *Grevillea* enthusiasts and members of the *Grevillea* Study Group and the encouragement of J. McGeogh, Birkdale Nursery, and E. Bunker, Redlands Greenhouses Holdings, is also recognised.

References

Beal, P. R. (1970). *G. banksii*: inheritance of flower colour in the intraspecific cross *Grevillea banksii* R.Br. forma *albiflora* (Degener) Deg. & Deg. x *Grevillea banksii* R.Br. Results of hybridising. *Australian Plants* **6**, 11.

Costin, R., and Costin, S. (1988). Tropical *Grevillea* hybrids. *Australian Plants* **14**, 335–43.

Elliot, W. R., and Jones, D. L. (1990). Grevillea. *In* 'Encyclopedia of Australian Plants Suitable for Cultivation'. Vol. 5. pp. 7–160. (Lothian Publishing Ltd: Sydney.)

Lacey, S. (1982). Vase life of *Grevillea* 'Sandra Gordon'. *In* 'Production and Marketing of Australian Wildflowers for Export/Production and Marketing of Wildflowers'. Proceedings, 1–4 November 1982. The University of Western Australia, Perth. pp. 111–13. (The University of Western Australia: Perth.)

Olde, P., and Marriott, N. (1994). 'The Grevillea Book.' Vol. 1. (Kangaroo Press: Kenthurst.) 255 pp.

Vuthapanich, S., Simons, D. H., and Turnbull, L. V. (1994). Effects of harvest maturity and postharvest treatments on vase life of *Grevillea* cv. 'Majestic' inflorescences. *In* 'Australasian Postharvest Conference Proceedings'. University of Queensland, Gatton College, Gatton. pp. 45–51.

Wrigley, J. W., and Fagg, M. (1989). 'Banksias, Waratahs and Grevilleas.' (Harper Collins Publishers: North Ryde.) 584 pp.

Received 24 April 1995, accepted 10 November 1995