PHYSIOLOGICAL AND MICROBIOLOGICAL PROCESSES OF CUT FLOWER SENESCENCE IN TWO AUSTRALIAN NATIVE GENERA, *ACACIA* AND *BORONIA*

by

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A thesis submitted for the degree of Doctor of Philosophy
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March 1996

DECLARATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Virginia G. Williamson

DEDICATION

To my parents, both of whom suffered serious illnesses during the period of my candidature. Their courage and determination is an inspiration.

FOREWORD

We are all limited by the beliefs that we carry throughout our lives, and we know not what will come next.

VGW
October 1995

ACKNOWLEDGEMENTS

My internal supervisor, Professor John A. Milburn, has always provided encouragement and support, which influenced my decision to continue on from an undergraduate plant physiology project and pursue postgraduate studies in the area of water relations. His clarity of explanation, patience and accessibility allowed for ease of discussion and expression of ideas, for which I am grateful.

My co-supervisor, Dr Daryl Joyce (Department of Plant Production, Horticulture Section, The University of Queensland, Gatton College) patiently answered my many questions on setting up the ethylene experiment. He also provided assiduous reading of my thesis chapters, for which I am grateful.

I appreciate the interest shown by two postharvest researchers, who suggested two of the experiments: Dr Wouter G. van Doorn (pers. comm. 1991) suggested that I monitor vase solution bacterial numbers throughout the *B. heterophylla* vase life experiment. He also drew my attention to the possibility that bacterial numbers in vase solutions are not necessarily indicative of the number of bacteria inside stems. Professor Michael S. Reid (pers. comm. 1993) suggested the DICA and AAE production experiment (section 4.3.5), in an attempt to eliminate bacteria as a cause of AAE production.

Rick Kenny provided technical assistance in calibrating and setting up various pieces of equipment, as well as numerous answers to technical questions. I was fortunate to have had access to such a knowledgeable technician. My thanks go to Dick Kent for assistance with the setting up and interpretation of bacterial identification tests; and Mathew Campbell, Ken Goulter and David Nehl, for supplementing my undergraduate knowledge of microbiology with practicalities. In addition, I am grateful to them and to Therese Honess and Emily Whitten, for their patience and good humour during my rather extended use of their facilities and laboratory space. I am thankful to Peter Garlick and Rick Porter for doing the scanning electron microscopy preparations of critical point drying and specimen coating, and particularly for their willingness to perform these procedures on weekends, as was sometimes unavoidable. Peter Garlick operated the TEM for the ir k studies. Rick Porter did an excellent job of printing my SEM and TEM photos. I am particularly grateful for the technical help I received outside the Botany Department: Dan Alter (Department of Agronomy and Soil Science), Marion Costigan and Colleen Rowbottom (Department of Chemistry), who introduced me to gas analysis. Additionally, Dr David Tucker (Department of Chemistry) allowed me access to technical assistance and the gas chromatograph. The genuine interest that all these people showed in my work was refreshing.

Statistical advice was provided by the following people: Dr Ian Davies, Dr David Smith, Patrick Laplagne, Dr Peter Clarke, Dr Demi Magcale-Macandog and Dr Michelle Casanova. Thanks to their patience, my confidence has grown in this area. I am particularly grateful to Dr Ian Davies (Department of Mathematics, Statistics and Computing Science) for the excellent and patient explanations he provided to my statistical questions.

Miscellaneous, but indispensable, advice and help came from many kind people. Dr Rod Jones provided advice, and also arranged for me to visit the Institute for Horticultural Development, Knoxfield, Victoria in 1991. Mrs Janyce Truett (IHD) told me some of her vase life results for *Acacia* and *Boronia heterophylla*. Associate Professor Gerry Woolsey (Physics Department), confirmed that the diffusive resistance equation did not need to be modified for decreased aperture area of the vapour cup. Dr Jeremy Bruhl patiently fielded my pedantic taxonomic queries. Raelee Kerrigan scanned my rose drawings into Omnipage and then into Microsoft Word. Patrick Laplagne, kindly added text and scanned the document into my thesis chapter after my many hours of attempts failed. Terry Brown, Frank Dyer and Brad Dawson fixed sick data loggers and electrical equipment at short notice. Dr Brian Butterfield (Department of Plant and Microbial Sciences, University of Canterbury, New Zealand) kindly attempted to answer my 'help' query about the SEM photos, and sent me several reprints to assist in the interpretation of "amorphous" deposits. Professor Karl H. Kreeb (University of Bremen, Germany) acted as "go-between", printing out from e-mail some of my lengthy chapters and appendices for Prof. Milburn to read while on study leave. Hazel Smith drew my attention to references citing the cold requirement for floral initiation in *Boronia*. Warren Sheather and Rick Kenny helped locate the *Acacia amoena* field site and assisted in collection of material. Martin Witchard and Patrick Laplagne also helped me collect plant material. In addition, Patrick Laplagne kindly helped me prepare hundreds of *A. amoena* stems for a pressure chamber experiment. Associate Professor William Noble (Psychology Department) and Steve Perrett showed extreme patience in allowing me rather prolonged use of an acoustically isolated chamber in which I conducted AAE detection experiments. Lyn Gay (Armidale Florist and Nursery) tracked down florist suppliers for me, and filled my specific rose cultivar orders at cost prices. Barbara Blenman, Rosemary Torbay and Cameron Barnes were always willing to help solve my Microsoft Word problems. Shirley Dawson and Chris Barnden expertly fulfilled my (macro)photographic requests. Dr Demi Magcale-Macandog provided friendship, help and moral support, the latter being particularly relevant during my early ventures to the extremely unfriendly UNIX mainframe for statistical analyses. Dr Michelle Casanova cheerfully and promptly proof-read my thesis and gave encouraging feedback. My dear mother, Wendie Williamson, saved me a great deal of time by assiduously checking off all my cited references.

Several people either did translations for me (Mrs Gerda and Dr Martinus van Houtert, Dr Paul Broese van Groenou) or sent me article translations (Dr Rod Jones, Dr Margaret Sedgley and Dr

Lindy Coates). Patrick Laplagne pa:iently checked and corrected my French translations, and Véronique Béghin filled in any missi ıg scientific words.

The receipt of an Australian Postgr: duate Research Award is gratefully acknowledged. I am also grateful to the Australian Flora Foundation for providing the funds to buy the native plants (except *Acacia*) used in this study. In particular, Dr Richard Williams and Bill Payne spent a great deal of time tracking down the required species. Provision of facilities by the Botany Department, UNE, are greatly appre:iated. I am also appreciative of grants from the Friends of Botany Fund, and also a Noel C.W. Beadle Grant in Botany.

The postgraduate students in the Department of Botany, UNE, have enabled my postgraduate training to be an enjoyable and happ/ experience. I will carry with me many fond memories of the special comradery that built up amongst so many of the Botany postgrads.

Finally, my economist husband, Pa rick Laplagne, thrown into the world of cut flower plant physiology since my Honours year, has shown a remarkable amount of patience and interest in this area, despite doing his Ph.D. at the same time as mine. I am very fortunate to have had his love and support during these distrac:ed times.

I value the friendships I have made during my candidature. The last few years have been a difficult, but enjoyable, time of my life.

ABSTRACT

Physiological and microbiological cut flower senescence processes in two Australian native genera, *Acacia* and *Boronia*, were determined. Vase life of the two *Acacia* spp. tested, *A. subulata* and *A. floribunda*, was not affected by exposure to ethylene (50 and 500 μL L^{-1} respectively for 24 h). No detectable levels of ethylene were produced by either species at different stages of floral development. Pulsing with silver thiosulphate (STS) (10.5 mol m^{-3} for 16.5 h), an inhibitor of ethylene action, did not increase vase life over that in distilled water. However, citric acid (10 mol m^{-3}) significantly improved the vase life of *A. amoena* compared with distilled water. Cavitation events (audible acoustic emissions, AAE) were recorded for the first time in cut flowers kept in vase solutions. AAE production peaked markedly in *A. amoena* stems after 48 h in distilled water. This coincided with abbreviated vase life, a sharp decrease in xylem water potential (to -3.7 MPa), and decreased hydraulic conduction (29% of the initial rate). Pectinaceous deposits in xylem conduits of stems kept in distilled water were not evident until 36 h (14% of conduits filled) and by 120 h had increased to 82%. This indicates that pectin deposition is a secondary event which occurs after water column disruption. Vase solution bacteria did not produce pectolytic enzymes, so were not responsible for pectin release from cell walls. In citric acid, no pectinaceous deposits were evident, even after 120 h. AAE production remained low in citric acid throughout the 120 h experimental period, although the xylem water potential decreased from -0.42 to -2.62 MPa between 48 and 60 h. Hydraulic conduction was 50% of the initial rate after 48 h. It was hypothesised that citric acid degraded pit membranes, resulting in less potentially cavitatable compartments, and improved hydraulic conduction rates. This hypothesis was supported by the distance travelled by paint in xylem conduits of stems kept in either distilled water or citric acid for 2 d. Paint particles, which should be stopped by pit membranes, were carried over 100% farther and in more conduits in stems kept in citric acid (9.8 cm) than in distilled water (4 cm). Stems in citric acid had the significantly greatest relative water content (RWC) (71.4%) after 120 h. The RWC of stems in distilled water (19.4%) was significantly less than that of stems in *Pseudomonas fluorescens* (10^6 cfu mL^{-1}) (44.3%). AAE production was not expedited by high levels (10^6 cfu mL^{-1}) of mixed or pure (*Ps. fluorescens*) bacterial populations. Thus, bacteria did not promote AAE production or decrease longevity.

In contrast with *Acacia*, the vase life of *Boronia heterophylla* and *B. crassipes* × *B. heterophylla* 'Lipstick' was shortened by ethylene, as longevity was significantly increased in stems protected against ethylene action with an STS pulse. However, in two other *Boronia* spp., *B. clavata* and *B. muelleri* 'Sunset Serenade', longevity was not significantly increased by pulsing with STS. In *B. heterophylla*, bacterial numbers were significantly greater in STS treatment vase solutions. Vase solution bacterial numbers had no significant influence on longevity ($\bar{R}^2 = 0.000$). These results indicate an overriding influence of ethylene in flowers which are sensitive to it, and the ambiguous role of bacteria in cut flower senescence.

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SYMBOLS:

°C	(temperature in) degrees Celsius
h	hour/s
λ	wavelength
μm	micrometre
μS	microSiemens
mOsm	milliosmoles
ms	milliseconds
min	minute/s
nm	nanometre
N	newton
Ψ_p	xylem pressure potential
s	second/s
t	time
W	watt

(Note that, for convenience, the symbol, L, for litre is used throughout this thesis rather than the SI unit of dm^3.)

ABBREVIATIONS:

AAE	audible acoustic emission/s
AD	air dried
cfu	colony forming units
cm	centimetre
CPD	critical point dried
DW	dry weight
FD	freeze dried
FH	frozen-hydrated
FID	flame ionisation detection
fw	fresh weight
8-HQC	8-hydroxyquinoline citrate
MPa	megapascals
p.a.	per annum
PAR	photosynthetically active radiation
PCA	plate count agar
ppm	parts per million

RH	relative humidity
RWC	relative water content
SCC	silver thiosulphate, citric acid and stabilised chlorine
SDIC	sodium dichloroisocyanurate (stabilised chlorine)
SEM	scanning electron microscopy
SSE	south-south-east
STS	silver thiosulphate
TEM	transmission electron microscopy
TSA	trypticase soy agar
TSB	trypticase soy broth

How often I regret that plants cannot talk.

Vita Sackville-West

(1892-1962)