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Factors affecting capsule and seed set in
***Eucalyptus globulus* seed orchards**

By

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Submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy

School of Agricultural Science, University of Tasmania,

February 2008

Declaration

I hereby declare that this thesis does not contain any material which has been accepted for a degree or diploma by the University of Tasmania or any other institution. To the best of my knowledge, this thesis contains no material previously published or written by another person except where due reference is made in the text of this thesis.

Shaun Suitor

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Shaun Suitor

Abstract

Low capsule seed set is a major factor limiting seed production in *Eucalyptus globulus* seed orchards. Trials were conducted in two Tasmanian *E. globulus* seed orchards to identify mechanisms involved in capsule abortion and low reproductive success. Key areas of investigation included identification of the timing of abortion relative to stage of capsule development, the impact of irrigation management and other treatments imposed to alter resource allocation, the influence of the maternal and paternal genotype, and relationship between floral characteristics and propensity of capsules to abort.

The major period of capsule abortion occurred between 20 and 80 days after pollination, coinciding with the period of capsule growth. A positive correlation between the number of fertilised ovules per aborted capsule and the length of time capsules were held on the tree was recorded. Given that capsule abortion occurred during a period of rapid fruit growth, and that capsules with the lowest number of fertilised ovules aborted first, it is argued that fertilisation level and resource availability to capsules are major factors determining abortion.

Flower density and irrigation treatments were imposed to assess the influence of resource allocation on capsule set. High flower density resulted in a high rate of abortion. Increased water availability resulted in increased vegetative growth which was associated with higher levels of capsule abortion. This suggested an irrigation mediated competition for resources between vegetative and reproductive sinks was contributing to capsule

abortion, and also suggested that irrigation management could be used to improve capsule yield within seed orchards.

Large variations in capsule and seed set, which combined determine reproductive success, between controlled crosses were identified. The contribution of the maternal and paternal parent to reproductive success and the genetic basis of this, were determined by the analysis of three data sets; operational scale breeding program crossing data, a full-sib mating scheme trial and pooled data obtained from the problem description and crop management trials within this PhD project. The analysis revealed that the variation in reproductive success was primarily determined by the maternal genotype and was heritable. The genetic differences in reproductive output appeared to be explained by differences in the physical properties of the flower, and the ability to support pollen germination and pollen tube growth.

In summary, capsule abortion mainly occurred during the period of capsule growth and the primary cause was concluded to be low levels of fertilisation. The level of fertilisation at which capsules were retained may vary depending on resource availability which is affected by factors including flower abundance, environmental conditions and crop management practices. Reproductive success has been shown to be primarily determined by the maternal parent and appears to be under genetic control, possibly resulting from genetic differences in the support of pollen germination and tube growth and floral physical characteristics.

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Preface

This thesis documents the research undertaken between November 2004 and February 2008. The project was initiated and funded by seedEnergy Pty Ltd, a company specialising in forestry seed production through seed orchard management. Much of the research has been published, submitted or in preparation for publication, and the thesis structure has incorporated these manuscripts as research chapters. An introduction chapter provides an overall context for the research chapters and a general discussion expands on the discussions presented in the research chapters.

Additional results that were not published have been included as appendices.

Publications from this project are as follows:

Refereed journal papers

Suitor, S, Potts, BM, Brown PH, Gracie, AJ and Gore, PL (2008). Post pollination capsule development in *Eucalyptus globulus* seed orchards. *Australian Journal of Botany*. **56**, 51-58.

Suitor, S, Potts, BM, Brown PH, Gracie, AJ and Gore, PL (2008). The influence of floral properties on the reproductive success of *Eucalyptus globulus*. Submitted to *Australian Journal of Botany*.

Suitor, S., Potts, BM., Pilbeam, DJ., McGowen MH., Brown PH., Gracie, AJ. and Gore, PL. 2008. The relative contribution of the male and female to the variation in reproductive success in *Eucalyptus globulus*. In preparation for submission to *Tree Genetics and Genomes*

Conference papers

Suitor, S, Potts, BM, Brown PH, Gracie, AJ and Gore, PL (2007). Factors affecting capsule set in *Eucalyptus globulus* seed orchards. *Eucalypts and Diversity: Balancing Productivity and Sustainability*. IUFRO Working Group 2.08.03. Durban, South Africa, 22nd-26th October. Paper 9, pp. 97. (CD Rom)

Potts, BM, McGowen, MH, Williams, DR, Suitor, S, Gore, PL and Vailancourt, RE (2007). Advances in reproductive biology and seed production systems of *Eucalyptus*: The case of *Eucalyptus globulus*. *Eucalypts and Diversity: Balancing Productivity and Sustainability*. IUFRO Working Group 2.08.03. Durban, South Africa, 22nd-26th October. Invited paper 132, pp. 42. (CD Rom)

Conference posters

Suitor, S, Brown, PH, Gracie, AJ and Gore, PL (2005). Factors Affecting Fruit Set in *Eucalyptus Globulus*, *Proceedings of the 8th International Workshop on Seeds*, Sheraton Brisbane Hotel, Brisbane QLD.

Suitor, S, Potts, BM, Brown, PH, Gracie, AJ and Gore, PL (2006). Capsule set management issues in *Eucalyptus globulus* seed orchards. Australian Forest Growers International Biennial Conference: “Sustainable forestry – everybody benefits”. Inveresk Cultural Precinct, Launceston, Tasmania.

Suitor, S, Potts, BM, Brown, PH, Gracie, AJ and Gore, PL (2006). Post pollination capsule development in *Eucalyptus globulus* seed orchards. Australian Forest Genetics Conference: Breeding for wood quality. The Old Woolstore, Hobart, Tasmania, Australia.

Contents

Declaration.....	3
Abstract.....	4
Acknowledgements.....	6
Preface.....	8
Contents	11
List of figures.....	Error! Bookmark not defined.
List of tables.....	Error! Bookmark not defined.
Glossary	Error! Bookmark not defined.
Chapter 1: Project Background and Context	Error! Bookmark not defined.
Industry background	Error! Bookmark not defined.
Seed production	Error! Bookmark not defined.
Life cycle, from bud initiation to capsule set.....	Error! Bookmark not defined.
Capsule or fruit abortion	Error! Bookmark not defined.
Management.....	Error! Bookmark not defined.
Scope of the project	Error! Bookmark not defined.
Chapter 2: Post pollination capsule development in <i>Eucalyptus globulus</i> seed	
orchards	Error! Bookmark not defined.
Introduction.....	Error! Bookmark not defined.
Materials and methods	Error! Bookmark not defined.
<i>Seed orchards</i>	Error! Bookmark not defined.
<i>Experimental design</i>	Error! Bookmark not defined.
<i>Pollen collection and storage</i>	Error! Bookmark not defined.
<i>Pollination</i>	Error! Bookmark not defined.
<i>Capsule and ovule development</i>	Error! Bookmark not defined.
<i>Statistical analysis</i>	Error! Bookmark not defined.
Results.....	Error! Bookmark not defined.

<i>Pollination types</i>	Error! Bookmark not defined.
<i>Timing of fall</i>	Error! Bookmark not defined.
<i>Capsule development</i>	Error! Bookmark not defined.
<i>Ovule development</i>	Error! Bookmark not defined.
Discussion	Error! Bookmark not defined.
Chapter 3: The impact of resource competition on capsule set in <i>Eucalyptus globulus</i> seed orchards and its manipulation through irrigation management....	Error!
Bookmark not defined.	
Introduction.....	Error! Bookmark not defined.
Materials and Methods.....	Error! Bookmark not defined.
<i>Experimental design</i>	Error! Bookmark not defined.
2004/2005 – <i>Flower density</i>	Error! Bookmark not defined.
2005/2006 – <i>RDI trial</i>	Error! Bookmark not defined.
2006/2007 – <i>PRD trial</i>	Error! Bookmark not defined.
<i>Statistical analysis</i>	Error! Bookmark not defined.
Results	Error! Bookmark not defined.
Discussion	Error! Bookmark not defined.
Chapter 4: The relative contribution of the male and female to the variation in reproductive success in <i>Eucalyptus globulus</i>	Error! Bookmark not defined.
Introduction.....	Error! Bookmark not defined.
Materials and Methods.....	Error! Bookmark not defined.
<i>Seed orchards and trees</i>	Error! Bookmark not defined.
<i>Experiments</i>	Error! Bookmark not defined.
<i>Pollinations and data collection</i>	Error! Bookmark not defined.
Results.....	Error! Bookmark not defined.
<i>Operational crossing</i>	Error! Bookmark not defined.
<i>Crossing diallel</i>	Error! Bookmark not defined.
<i>Stability of female success</i>	Error! Bookmark not defined.
Discussion	Error! Bookmark not defined.
Chapter 5: Variation in <i>Eucalyptus globulus</i> reproductive success can be explained by the properties of the flower	Error! Bookmark not defined.
Introduction.....	Error! Bookmark not defined.
Materials and Methods.....	Error! Bookmark not defined.
<i>Experimental design</i>	Error! Bookmark not defined.
<i>Pollination techniques</i>	Error! Bookmark not defined.
<i>Pollen collection, germination, growth and fertilisation</i>	Error! Bookmark not defined.
<i>Flower morphology</i>	Error! Bookmark not defined.
<i>Statistical analysis</i>	Error! Bookmark not defined.
Results	Error! Bookmark not defined.
<i>Style and flower physical characteristics</i>	Error! Bookmark not defined.
<i>Pollen tube growth and ovule penetration</i>	Error! Bookmark not defined.
Discussion	Error! Bookmark not defined.
Chapter 6 General discussion	Error! Bookmark not defined.
Recommendations for seed orchard management and future research.....	Error!
Bookmark not defined.	

Appendices	Error! Bookmark not defined.
Appendix 1. Correlation analysis, meteorological data vs. capsule abortion	Error! Bookmark not defined.
Appendix 2. Effect of Nectar Scarab beetles on capsule set....	Error! Bookmark not defined.
References	Error! Bookmark not defined.