

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

# **Effects of Some Preservative Solutions on Vase Life in *Gerbera jamesonii***

A research report presented in partial fulfilment of the requirements for the  
degree of

**Master of AgriScience**

At Massey University, Turitea Campus, Palmerston North, New Zealand

**Yushu Yan  
2016**



## Abstract

*Gerbera* (*Gerbera jamesonii* H. Bolus ex. Hooker) is an important ornamental flower in global flower market. Consumers are attracted by its bright colour and beautiful shape; but as with other cut flowers, quality loss after harvest is a major concern. Moreover, in certain cultivars, its vase life is dramatically shortened by a stem bending problem. 'Navy', an attractive new variety, caused customer complaints resulting from its short vase life, as a result of a high incidence of stem bending.

In this thesis, 2 – 6% sucrose was shown to be an effective preservative for preventing 'Navy' from stem bending. Furthermore, deeper research showed sucrose improved stem rigidity and did so by improving lignification of sclerenchyma fibres in the phloem caps and interfascicular region.

Once stem bending has been prevented by sucrose, it is also possible to delay underlying flower senescence. Certain antibacterial materials were tested and a preservative solution containing 4% sucrose and colloidal silver (3 or 5 ppm) was shown to be the best. This may be mainly due to effective control of bacteria and resulting reduction in water stress; but also it may delay flower senescence by inhibiting ethylene action (although most gerbera varieties that have been tested are ethylene insensitive). Just sucrose and colloidal silver is sufficient to keep 'Navy' flowers alive for three or four weeks; which should be enough for consumer demand.

There is quite limited knowledge on the mechanism of gerbera flower senescence. The sequence of 'Navy' senescence was shown to involve first a change in head angle which always occurred on day 11 after harvest. Water uptake mostly started to be affected from day 13 to 15. Most of the senescence-associated colour changes, including the values of 'L', 'a', 'b', began to change during day 15 to 20. Flower weight generally did not change too much, and accompanying with water uptake reduced (apart from the first experiment). Therefore, the results suggest visible initiation of 'Navy' senescence might start

at around 11 – 13 days after harvest, so investigations into underlying genetic regulation would need to start before this time.

## Acknowledgements

Firstly, I would like to express profound appreciation to my supervisors, Julian Heyes and Jason Wargent. Julian, without your patient guidance, enthusiastic recommendation and help, and consistent encouragement, it would be much harder for me to accomplish this thesis. I am very appreciated Julian for guiding me from designing my project to amending my thesis. I am really appreciated that you always try to cheer me up when I have no confidence and help me to release my pressure when I worried about whether I can finish my thesis successfully. Furthermore, I sincerely thank Jason for discussing my project and giving me helpful advices. Additionally, under huge support from both of you, I finally made it possible to work on a topic which was my interested. It was a big pleasure for me working with you.

I am grateful to Julia Good, who helped me to do bacteria test for the solutions of my 'Navy' Gerberas and guide me to work on micro lab. In addition, Sue Nicholson, Steve Glasgow, Ann-Marie Jackson, and Michelle Tamehana gave me lots of technical guidance and help me to do my work much more effective and convenient when I worked on your labs, I am so appreciated about that. Meanwhile, I want to express gratitude to Steven Ray, Lesley Taylor and Chris Rawlingson, and you helped me to set up equipment and materials what I need in my experiment. What is more, I want to say thanks a lot to Xiongzhaoh He who patiently taught me analysis statistical data and use SAS.

I sincerely appreciate PlentyFlora company supported me 'Navy' flowers, and gave me many useful information about gerbera, especially grateful to Harald Esendam for his great suggestions and attention on my project.

I would like to acknowledge the contribution of my family, relatives, and friends. They always encouraged me when I was upset, and believed in me all the time even when I didn't believe in myself.

Under all your great help, I luckily accomplish my project and thesis. Please allow me to say thank you here.

# Table of Content

Abstract .....	i
Acknowledgements.....	iii
Table of Content .....	iv
List of Figures .....	vi
List of Tables .....	ix
Abbreviations .....	x
Chapter 1 Introduction.....	1
1.1 Literature Review .....	1
1.1.1 Background of Gerbera .....	1
1.1.1.1 Brief for Gerbera and Its Industry.....	1
1.1.1.2 The Gerbera Industry.....	4
1.1.1.2.1 Growing .....	4
1.1.1.2.2 Harvesting .....	6
1.1.1.2.3 Postharvest Handling .....	6
1.1.2 Vase Life for Cut Gerbera Flowers .....	11
1.1.2.1 Stem Bending.....	12
1.1.2.2 Flower Senescence .....	15
1.1.2.3 Preservative Solutions Choices for Gerbera .....	24
1.2 Aims and Hypotheses .....	27
Chapter 2 Comparing the Effectiveness of Different Vase Life Solutions in ‘Navy’ .....	28
2.1 Introduction and Aim.....	28
2.2 Materials and Methods .....	30
2.2.1 Plant Materials .....	30
2.2.2 Measurements .....	34
2.2.2.1 Flower and Solution Weight .....	34
2.2.2.2 Flower Colour .....	34
2.2.2.3 Stem Angle.....	34
2.2.2.4 Vase Life .....	35
2.2.2.5 Bacteria Load .....	36
2.2.3 Statistics .....	37

2.3 Results .....	38
2.3.1 Flower Weight and Water Relations .....	38
2.3.2 Flower Colour Changes .....	45
2.3.3 Angle Changes.....	51
2.3.4 Vase Life Difference.....	53
2.3.5 Bacteria Number in Different Solution .....	55
2.4 Discussion .....	58
Chapter 3 Sucrose Affects the Lignification of ‘Navy’ Scape .....	64
3.1 Introduction and Aim .....	64
3.2 Materials and Methods .....	65
3.2.1 Plant Materials.....	65
3.2.2 Determination of Stem Mechanical Strength .....	65
3.2.2.1 Preliminary Test: Testing the Feasibility of Three-point Bend on Gerbera Stem.....	65
3.2.2.2 Strength of Gerbera Stem in Sucrose or Water.....	66
3.2.3 Determination of Anatomical Traits.....	66
3.2.3.1 Preliminary Test: Distinguishing the Degrees of Lignification .....	66
3.2.3.2 Lignification Degree of Gerbera Stem in Sucrose or Water .....	67
3.2.4 Statistics .....	67
3.3 Results .....	68
3.3.1 Determination of Stem Mechanical Strength .....	68
3.3.1.1 Preliminary Test: Testing the Feasibility of Three-point Bend on Gerbera Stem.....	68
3.3.1.2 Strength of Gerbera Stem in Sucrose or Water.....	69
3.3.2 Determination of Anatomical Traits.....	73
3.3.2.1 Preliminary Test: Distinguishing the Degrees of Lignification .....	73
3.3.2.2 Lignification Degree of Gerbera Stem in Sucrose or Water .....	76
3.4 Discussion .....	81
Chapter 4 Conclusion and Recommendations for Future Work .....	85
References.....	88
Appendix .....	104



## List of Figures

Figure 1.1: Gerbera flower and its petal category	2
Figure 1.2: Cut flowers at the Dutch Auctions, in % of turnover in 2013	3
Figure 1.3: Positions of programmed cell death in floral organs	17
Figure 1.4: A model for regulatory pathways in flower senescence	19
Figure 1.5: Components of the ethylene downstream signaling pathway	21
Figure 2.1: 'Navy' stored in controlled temperature room	31
Figure 2.2: Measurement of flower angle	35
Figure 2.3: The symptoms of the end of vase life	36
Figure 2.4: Fresh weight (g) of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	42
Figure 2.5: Water uptake (g/h) of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	43
Figure 2.6: Temperature of experiment 1, 2 and 4 in each day from the day after arrival to the day ending the experiment	44
Figure 2.7: Water uptake (g/h) of 'Navy' every two days on the day after flower arrival after modifying data in experiment 2	44
Figure 2.8: The original data of water uptake on the day after flower arrival in experiment 1	45
Figure 2.9: Colour 'L' of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	48
Figure 2.10: Colour 'a' of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	49
Figure 2.11: Colour 'b' of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	50
Figure 2.12: The original data of colour 'b' on the day after flower arrival in experiment 1	51
Figure 2.13: Angle of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	52

Figure 2.14: Vase life of 'Navy' in experiment 1(A), 2 (B), 4 (C)	54
Figure 2.15: Vase life of 'Navy' in experiment 3	55
Figure 3.1: Diameter (mm) of gerbera stem at different distances (cm) to flower head	68
Figure 3.2: Stem strength (N) of gerbera stem at different distances (cm) to flower head	69
Figure 3.3: Displacement to peak load (mm) of gerbera stem at different distances (cm) to flower head	69
Figure 3.4: Diameter (mm) of gerbera stem at original 5 cm point below flower head	70
Figure 3.5: Stem strength (N) of gerbera stem at original 5 cm point below flower head	70
Figure 3.6: Displacement to peak load (mm) of gerbera stem at original 5 cm point below flower head	71
Figure 3.7: Diameter (mm) of gerbera stem at original 10 cm point below flower head	71
Figure 3.8: Stem strength (N) of gerbera stem at original 10 cm point below flower head	72
Figure 3.9: Displacement to peak load (mm) of gerbera stem at original 10 cm point below flower head	72
Figure 3.10: Different colour degree for vascular bundles in gerbera stem	74
Figure 3.11: Different Interfascicular region width degree in gerbera stem	75
Figure 3.12: Auto-fluorescence colour of lignified tissues at different distance to flower head	76
Figure 3.13: Proportion of thickness of interfascicular region	76
Figure 3.14: Percentage distribution of vascular bundle 'colour categories' by treatment at original 5 cm point below flower head	77
Figure 3.15: Percentage distribution of vascular bundle 'colour categories' by treatment at original 10 cm point below flower head	78

Figure 3.16: Percentage distribution of interfascicular region width by treatment at original 5 cm point below flower head	79
Figure 3.17: Percentage distribution of interfascicular region width by treatment at original 10 cm point below flower head	80
Figure 1: Plant growth (g/h) of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	104
Figure 2: Transpiration (g/h) of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	105
Figure 3: Colour 'C' of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	106
Figure 4: Colour 'h°' of 'Navy' every two days in experiment 1(A), 2 (B), 4 (C) on the day after flower arrival	107

## List of Tables

Table 1.1: Five gerbera categories based on flower forms	2
Table 1.2: Categories of flowers responding to ethylene	18
Table 2.1: Chemicals and their concentration used in experiments	29
Table 2.2: The number of flowers being tested in different day after flower arrival	32
Table 2.3: Original flower weight (g) of flower on the first day after flower arrival	38
Table 2.4: The log count of bacteria number in experiment 2 on day 8 after flower arrival	56
Table 2.5: The log count of bacteria number in experiment 3 on day 11, 21 and 31 after flower arrival	56
Table 2.6: The log count of bacteria number on in experiment 4 on day 8, 15 and 22 after flower arrival	57
Table 3.1: Chi-squared analysis of distribution of vascular bundle 'colour categories' by treatment at original 5 cm point below flower head	77
Table 3.2: Chi-squared analysis of distribution of vascular bundle 'colour categories' by treatment at original 10 cm point below flower head	78
Table 3.3: Chi-squared analysis of distribution of interfascicular lignification extent by treatment at original 5 cm point below flower head	79
Table 3.4: Chi-squared analysis of distribution of interfascicular lignification extent by treatment at original 10 cm point below flower head	80
Table 1: The log count of bacteria number on experiment 1 on day 13 after flower arrival	108

## Abbreviations

8-HQC:	8-hydroxyquinoline citrate
8-HQS:	8-hydroxyquinoline sulfate
ABA:	abscisic acid
ACC:	1-aminocyclopropane-1-carboxylic acid
ACO:	ACC oxidase
ACS:	ACC synthase
AgNO <sub>3</sub> :	silver nitrate
AOA:	amino-oxyacetic acid
AOPP:	$\alpha$ -aminooxi- $\beta$ -phenylpropionic acid
AP:	apoptotic-like mechanism
AU:	autophagous-like mechanism
BA:	benzyl adenine
CaCl <sub>2</sub> :	calcium chloride
CHS:	chalcone synthase
CMS:	cytoplasmic male sterility
DFR:	dihydroflavonol-4-reductase
Dfs:	disc florets
ER:	endoplasmic reticulum
GA:	gibberellic acids
GDP:	geranyl diphosphate
JA:	jasmonic acid
MAP:	modified atmosphere packaging
MAPK:	MAP kinase
MTs:	cortical microtubules
PAL:	phenylalanine ammonia-lyase
PAs:	polyamines
PGRs:	plant growth regulators

PCD:	programmed cell death
PE:	polyethylene
PP:	polypropylene
PVC:	polyvinylchloride
Rf:	ray floret
ROS:	reactive oxygen species
UV:	ultraviolet
SA:	salicylic acid
SAGs:	senescence associated genes
SAM:	S-adenosyl methionine
SI:	self-incompatibility
TFs:	signal transduction and transcription factor

