THE UNIVERSITY OF QUEENSLAND
AUSTRALIA



Postharvest practices for Protea perfection

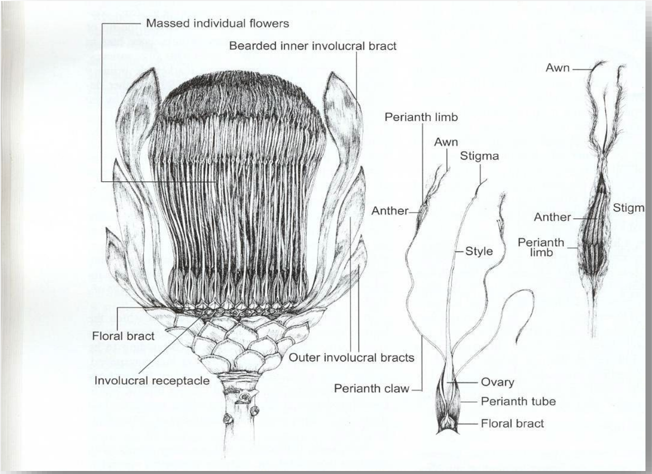
with focus on *Protea*, *Leucospermum* & *Leucadendron*,
from a South African perspective

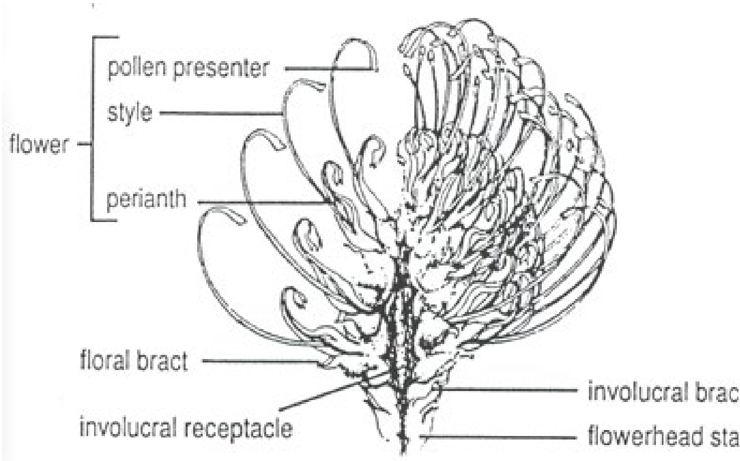
Lynn Hoffman

Product characteristics: unique & diverse

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

- Woody stems with inflorescences with
  - Showy involucral bracts (*Protea*), flowers with perianth,
    - which can be prominent or insignificant
  - Involucral bracts are absent, but with a showy perianth

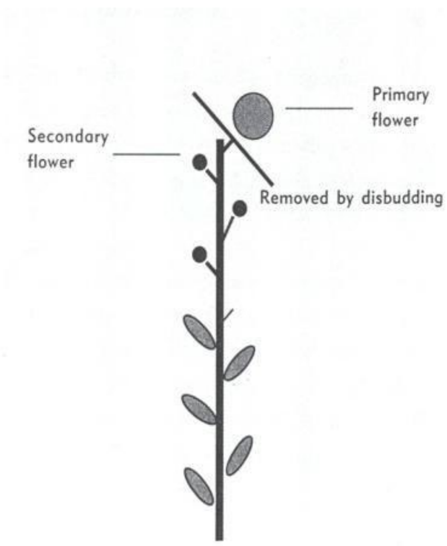




Product characteristics: unique & diverse

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

- Woody stems with inflorescences with
  - Flowers is borne terminally (*Protea*) or in an a
    position (*Leucospermum*) as focal flower or as
  - Sprays (*Serruria*)



Product characteristics: unique & diverse

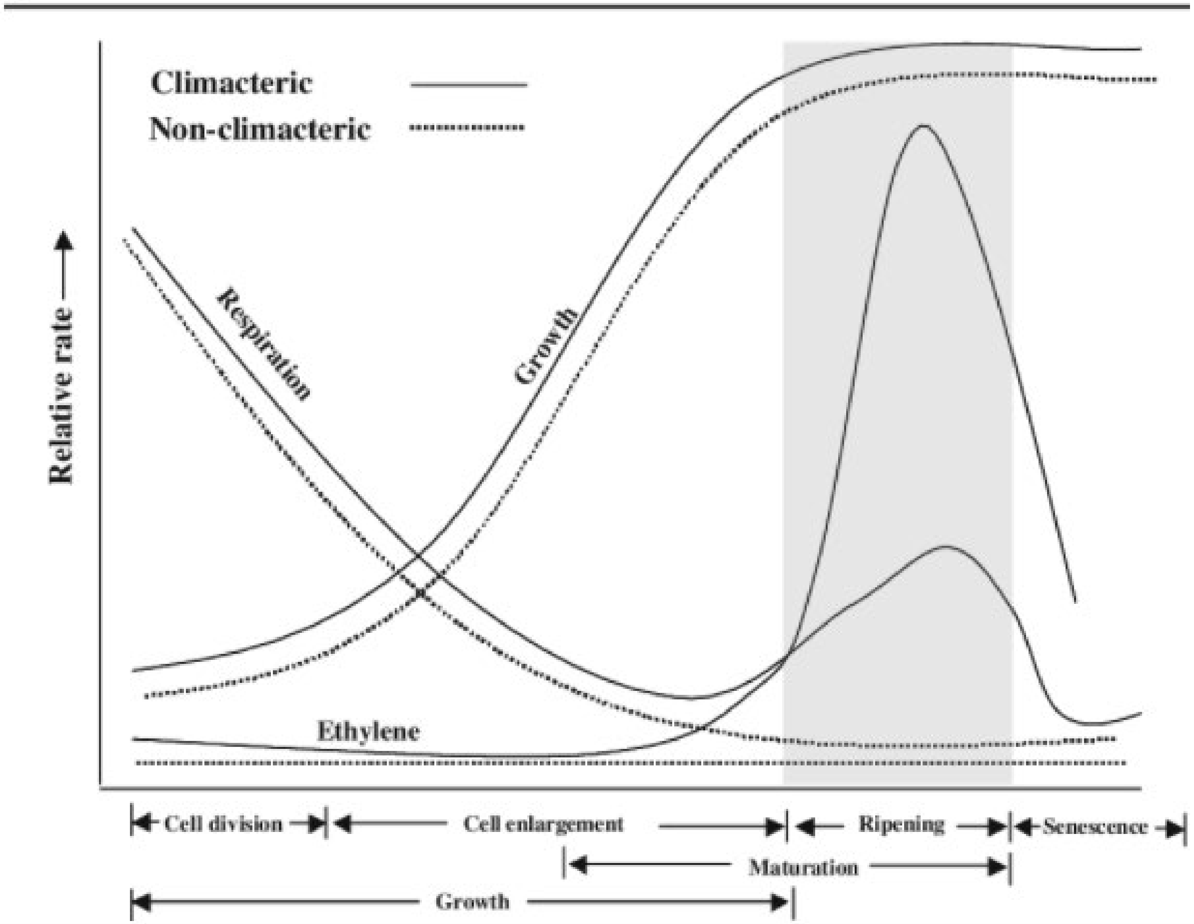
- Woody stems where the foliage is the attractive feature of the product, within a bouquets
  - the product can be sold purely as a filler product within bouquets
  - Or as focal stems, based on the foliage
  - Or as focal stems for their showy cones

High Respiration rate

↑ RESPIRATION = ↑ USAGE OF RESERVES = ↑ SENESCENCE

Class	Respiration 5°C mg·kg^{-1}·h^{-1}	Product	Predicted shelflife
Very Low	< 5	nuts, dates	6 -12 months
Low	5 to 10	onion, potato, apple, garlic, citrus, watermelon, melon	3 - 6 months 8 -12 weeks 2 - 3 weeks
Moderate	10 to 20	tomato, cabbage, peppers, lettuce, banana, cucumber, carrot,	2 - 5 weeks 2 - 3 weeks 2 weeks
High	20 to 40	cauliflower, avocado, celery, strawberry, raspberry,	2 - 3 weeks 7 days 3 - 6 days
Very high	40 to 60	artichoke, bean, cutflowers, eggplant, fennel	7-10 days
Extremely high	>60	asparagus, brocolli, mushroom, spinach, pea, sweet corn	7 days

Non-climacteric products, unlike carnations



Perception: long vase life, but limited storability

Impact of COVID lockdown on flowers sales

https://theconversation.com/valentines-day-covid-19-wilted-the-flower-industry-but-sustainability-still-a-thorny-issue-154889

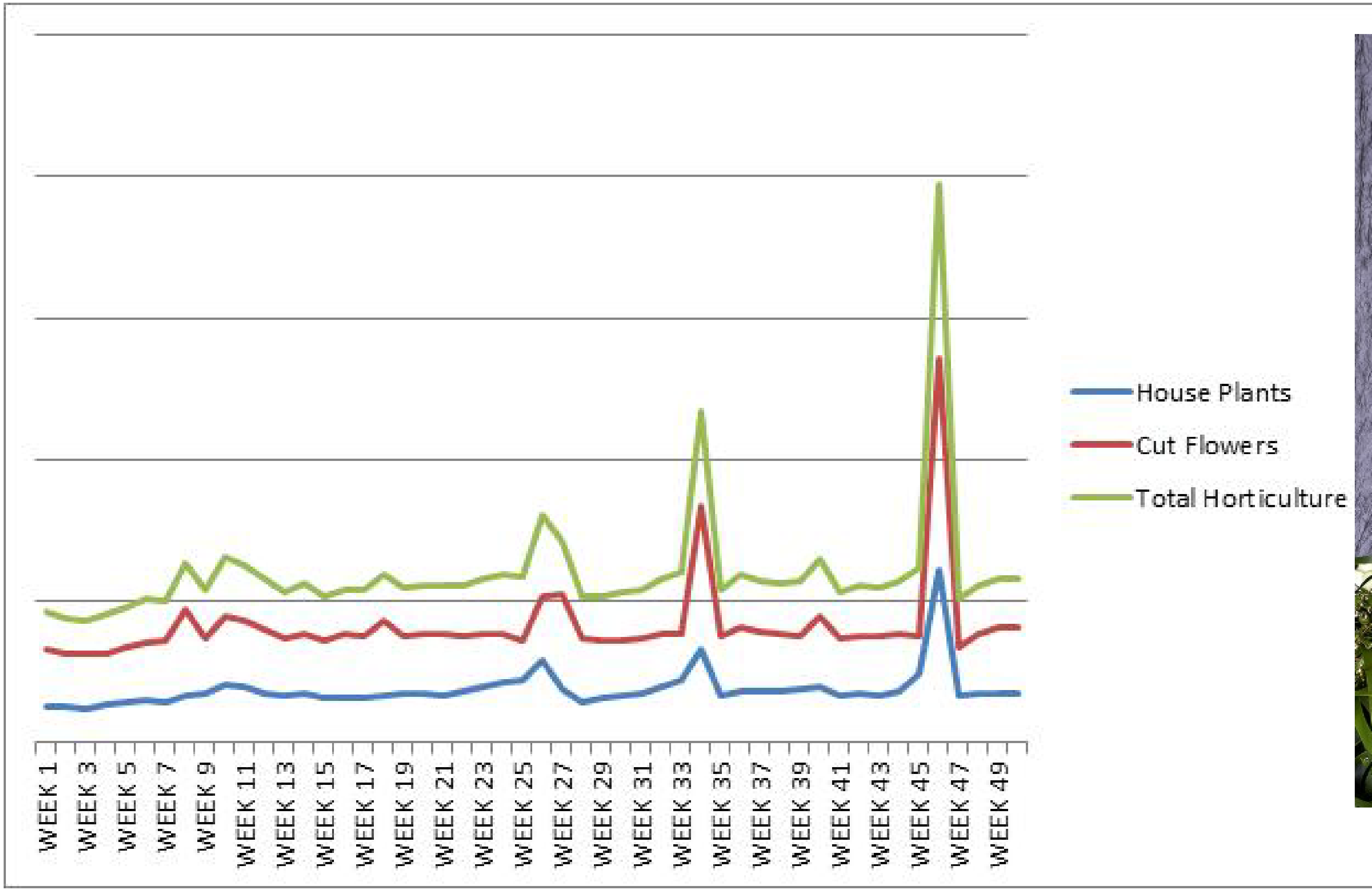
Flower shop employees destroy unsold flowers in St. Petersburg, Russia, after shops were ordered closed to limit the spread of the coronavirus, on Apr. 13, 2020. (AP Photo/Dmitri Lovetsky)

Flower grower Joe Oliveri dumped 50,000 gerberas last week and expects more will go to waste as sales plummet. *(Supplied: Joe Oliveri)*

https://www.abc.net.au/news/2020-03-30/flowers-dumped-as-coronavirus-closes-events-and-florists/12100998

Compared to a product where postharvest protocol allows for extended storage periods

Increased flowers sales on special occasions requires good postharvest planning

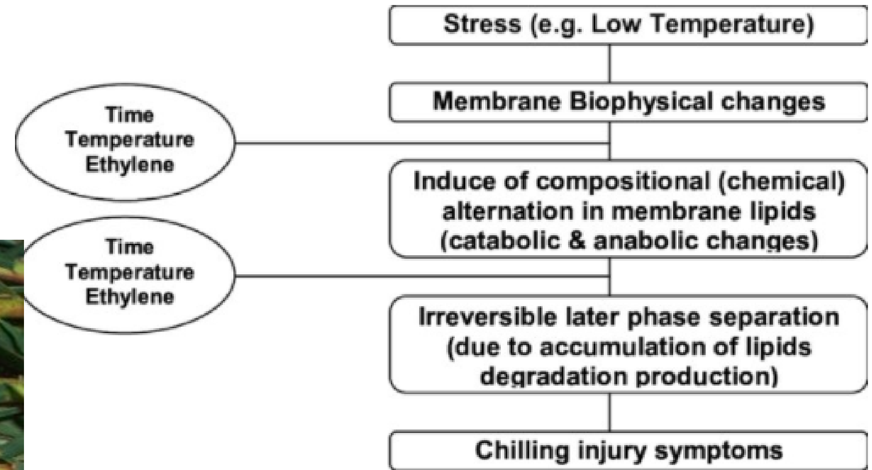


Factors affecting postharvest life of ornamentals

1. Genotype
2. Preharvest & harvest factors
3. Temperature & storage duration
4. Controlled & Modified Atmosphere
5. Water relations
6. Ethylene and other hormones/PGR
7. Disease & damage from handling
8. Growth and tropic responses
9. Pulsing (carbohydrate/ ethanol)

Physiological postharvest disorders

- Chilling injury: <5°C
  - Biophysical & phase changes of the membrane, resulting in changes in permeability & electrolyte leakage



Symptoms of chilling injury:

- wilting of leaves,
- discoloration of flowers/petals, water-soaked tissues,
- necrosis of leaves,
- accelerated water loss & dehydration;
- increased susceptibility to attach by pathogens

Physiological postharvest disorders

The University of Queensland Australia

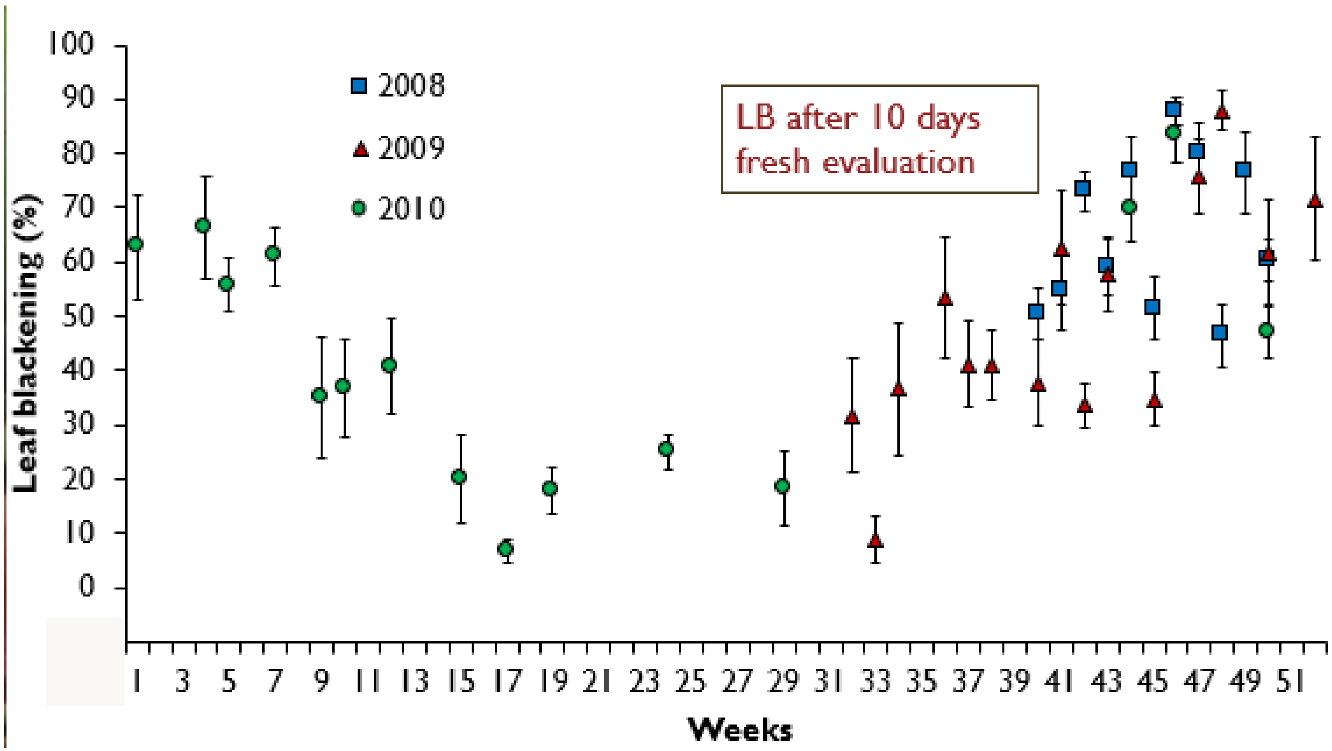
- **Leaf blackening in *Protea***
  - Can manifest 3 – 5 days after harvest
  - Affects a wide range of species/cultivars including *Protea* 'Sylvia' (*P. eximia* x *P. susannae*)
  - Carbohydrate-deficiency (flower development/ nectar demand)
    - O-glycoside esters present in leaf blackening susceptible *Protea* species are hydrolyzed during stress/post harvest.
    - This would release the sugar moiety for translocation to the developing flowerhead
    - and a highly reactive free phenolic moiety which on being oxidized effectively blackens the leaf

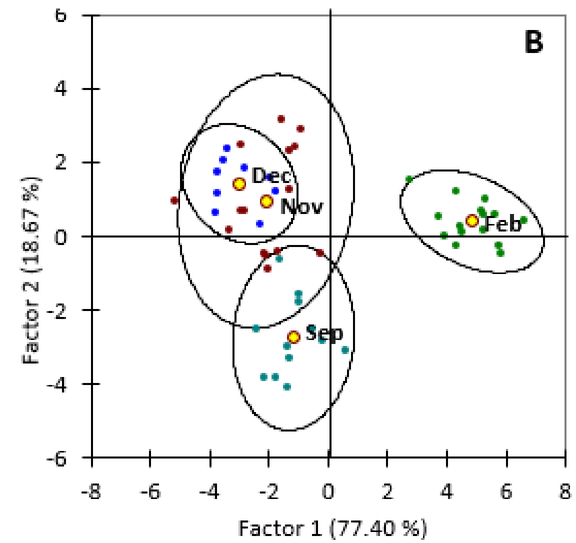
Harvest maturity

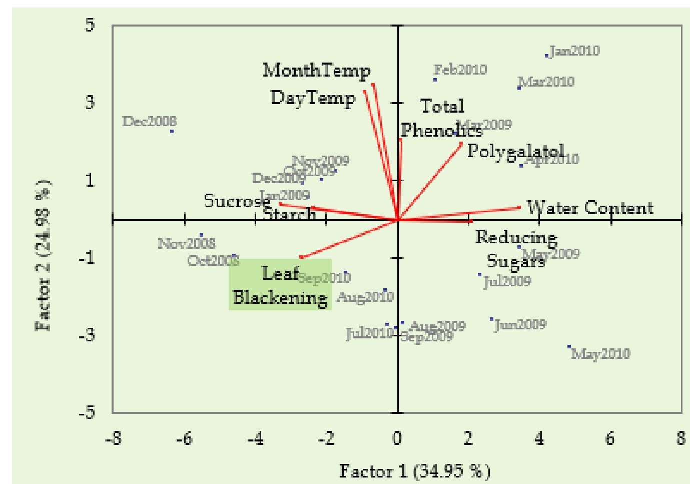
- Developing *Protea* flower heads have a higher respiration rate, thus inclined to result in more leaf blackening
- Outer ring of pollen presenters released in *Leucospermum* to ensure opening, very immature flowerheads may be recovered from desiccation during transport & storage
- *Leucadendron* has better storability when coordinated with flowering or cone formation, but susceptible to chilling injury as foliage product

Leaf blackening varies over the season

Nicole Windell



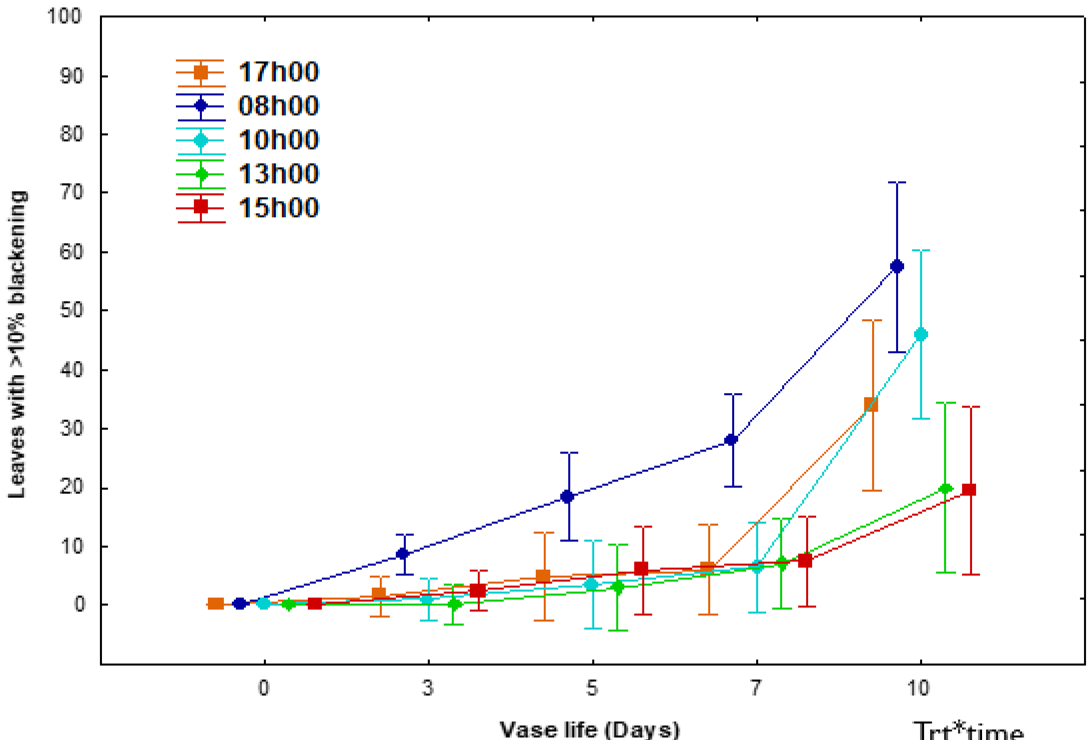




Harvesting

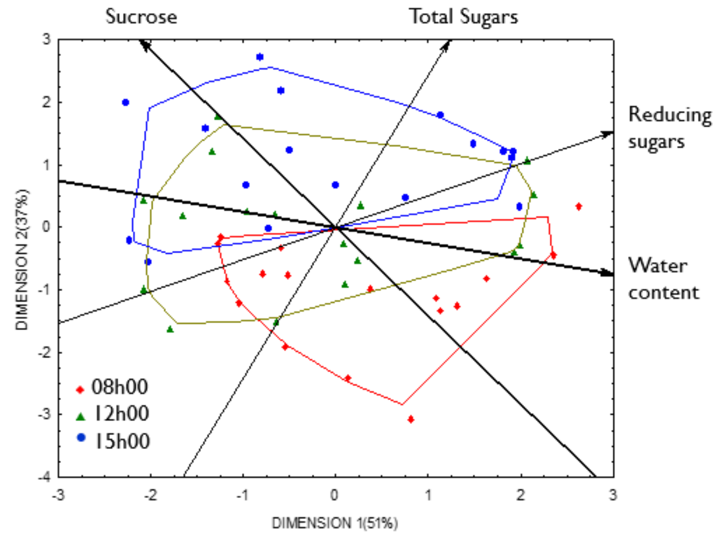
Nicole Windell

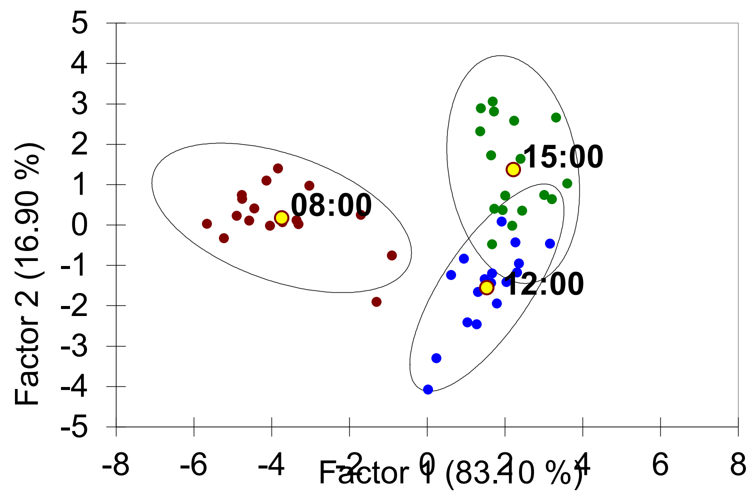
Leaf blackening varies with time of day



n = 10

Trt*time
$p < 0.0001$





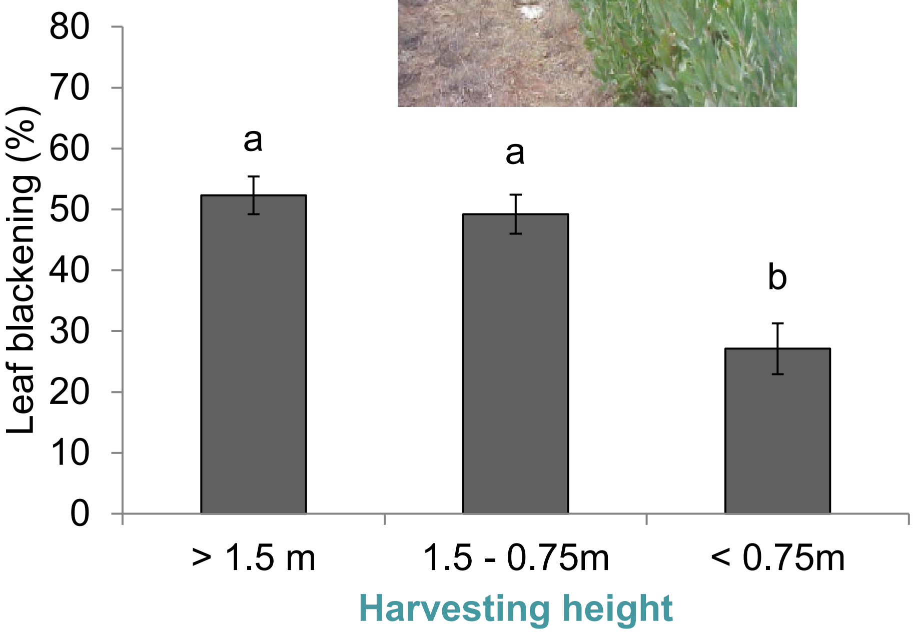
Harvesting: stem quality & position on tree

The University of Queensland
Australia

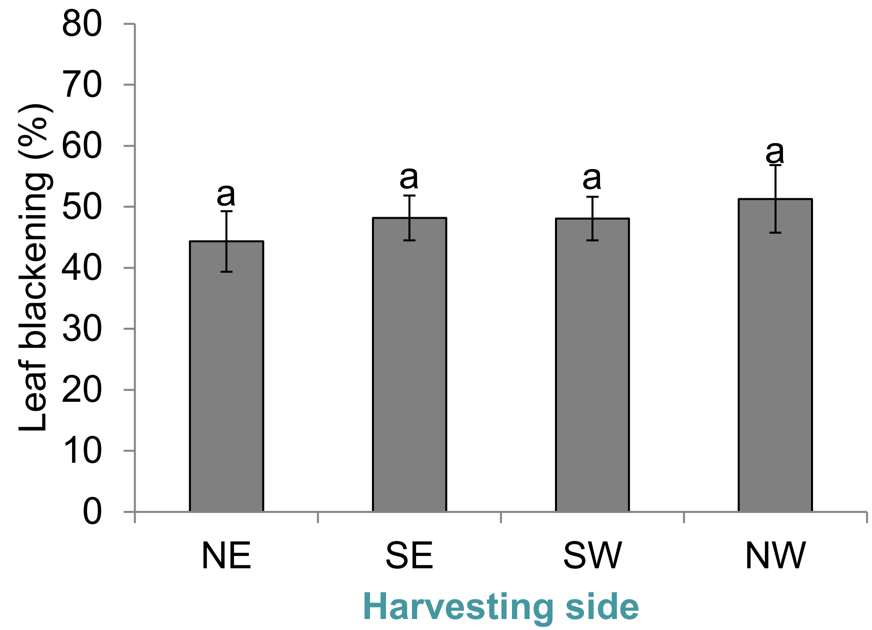
Leaf blackening varies according to stem length, but not harvesting position on tree

Nicole Windell

$p = 0.0006$

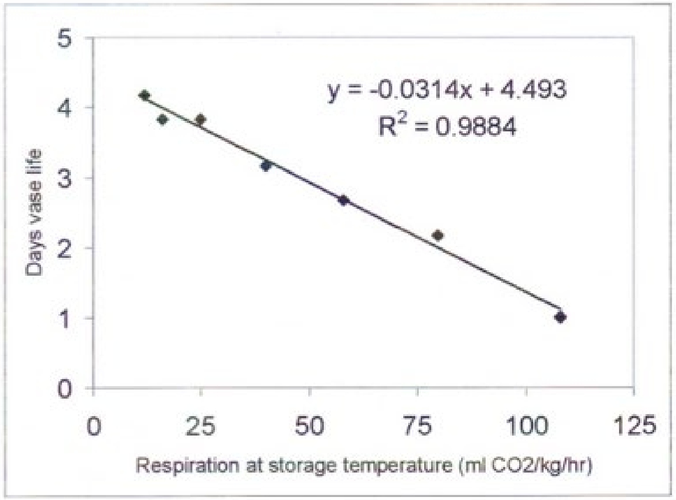


$p = 0.6263$



Cold chain management

- Benefits from low temperature storage:
  - Reduced metabolism, so reduced rate of product deterioration/senescence
  - Reduced water loss
  - Reduced loss of respirable substrate (sugars)
  - Reduced pathogen growth (*Botrytis*)
  - Undesirable growth & development



- What is the optimum long-term storage temperature?
  - Temperate cut flowers in general: 0°C-1°C
  - Foliage plants & tropical flowers: 7-10°C
  - <u>Proteaceae?:</u>
    - *Telopea*: 0-2°C for 2 week period, but not 4 weeks (Faragher., 1986)
    - *Grevillea*: 0°C (stored dry) for 12 days; but not 5 of 10°C (Joyce et al. 2000)
    - *Leucadendron:* 2°C at 80% RH (Philosoph-Hadas et al. 2010)
    - *Leucospermum:* 1°C for 24 days had chilling injury but not >4°C

Storage temperature: Temp x duration x sensitivity

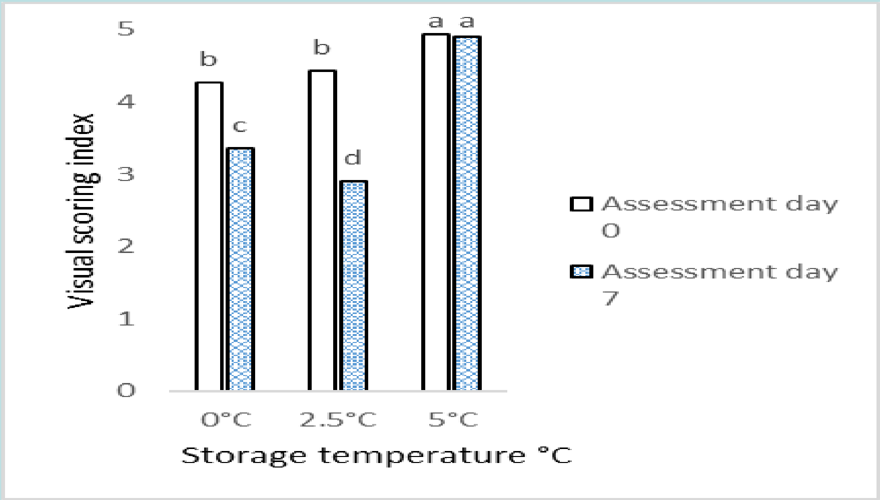
Heleen van Zyl

Product & cultivar specific: Leucadendron

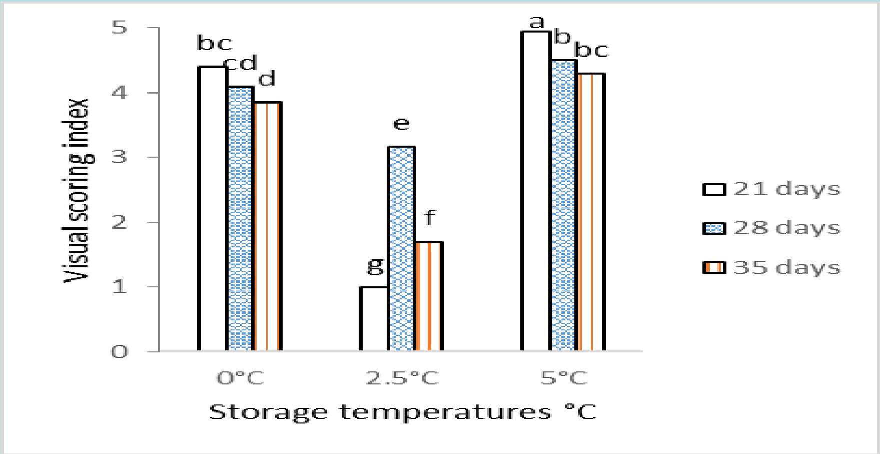
Storage at 0°C; 2.5°C; 5°C
for 3, 4 & 5 weeks

5= no damage;
1= extreme damage

'Chameleon'



'Laurel Yellow'



Storage temperature: Temp x duration x sensitivity

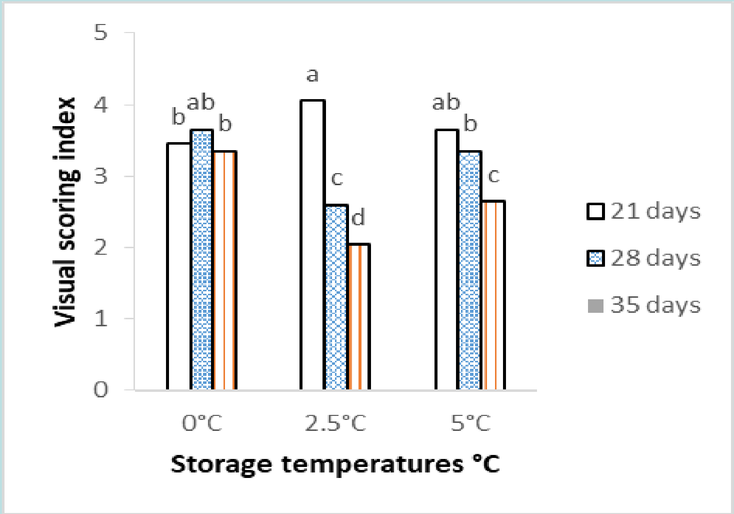
Heleen van Zyl

Product & cultivar specific: Leucadendron

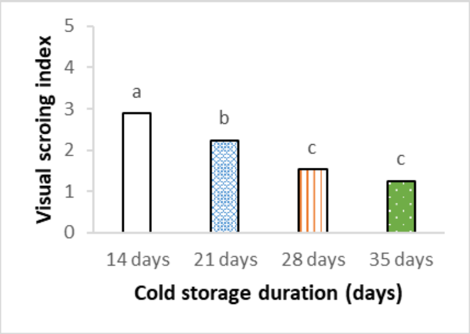
Storage at 0°C; 2.5°C; 5°C
for 3, 4 & 5 weeks

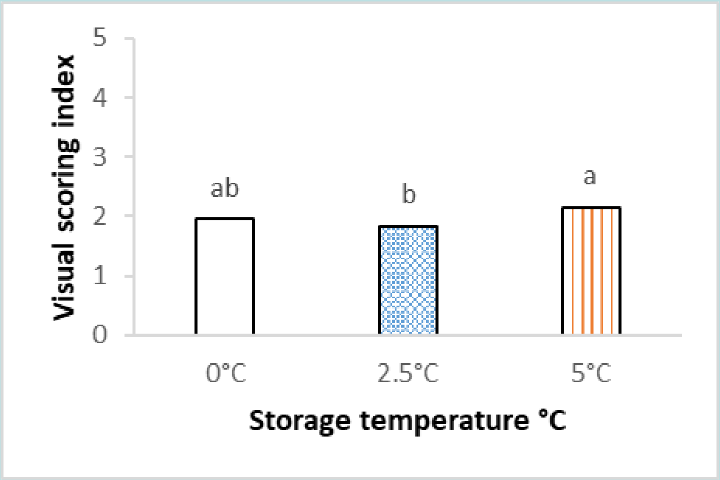
5= no damage;
1= extreme damage

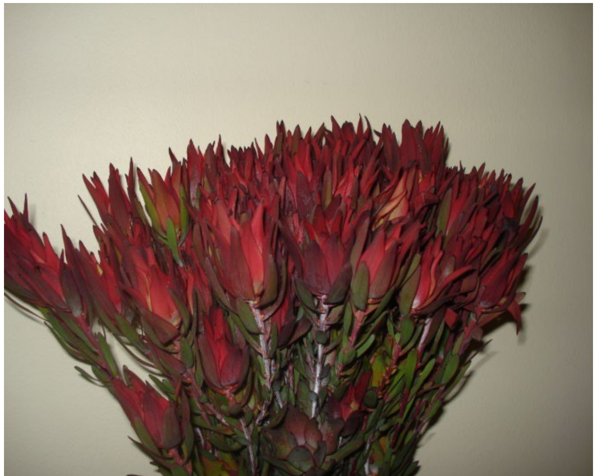
'Inca Gold'



'Blush'







Storage temperature: Temp x duration x sensitivity

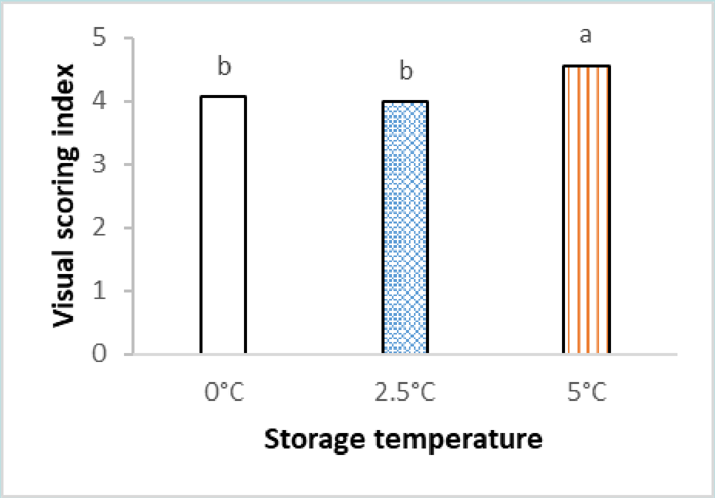
Heleen van Zyl

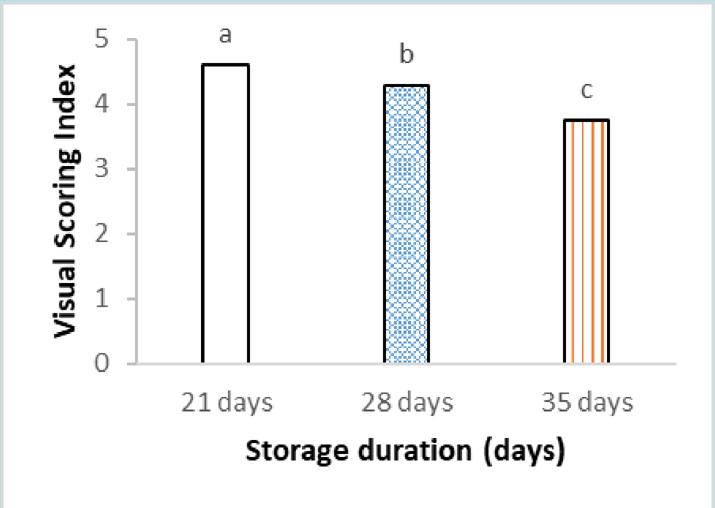
Product & cultivar specific: Leucadendron

Storage at 0°C; 2.5°C; 5°C
for 3, 4 & 5 weeks

5= no damage;
1= extreme damage

'Safari Sunset'





The University of Queensland

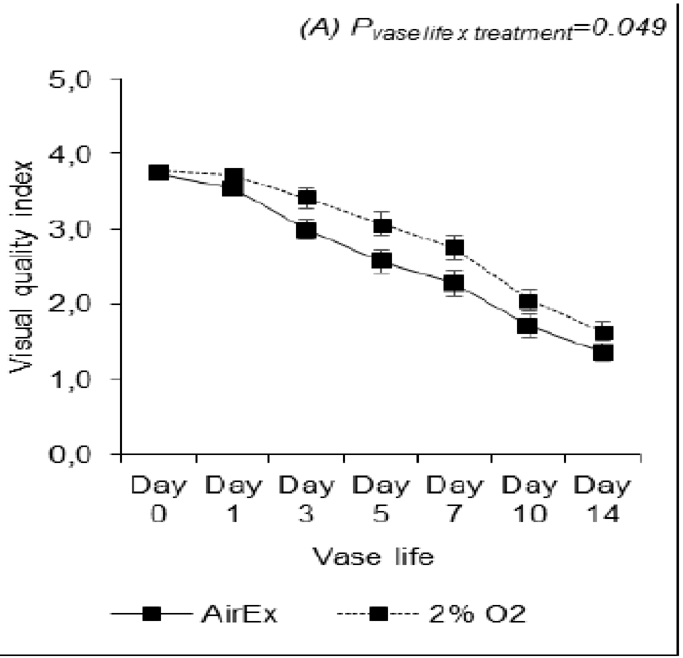
Feasibility of closed ventilation and automatic ventilation for sea freight of *Proteaceae* cut flower stems

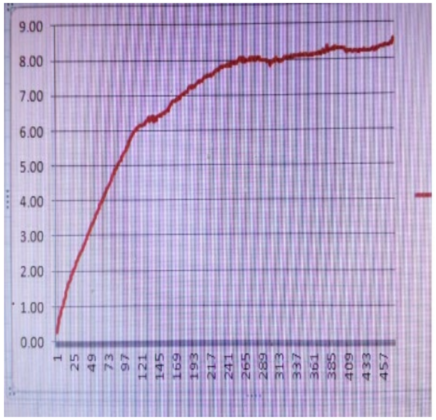
Stenford Matsikidize

- Respiration rates under closed ventilation & automatic ventilation at 5 and 15 °C
- Lower oxygen limits (LOL values): 0.08 to 0.48% O_2 ; CO_2 at 0,04%
- CO_2 toxicity tolerance limits for a range of Proteaceae products: ramped 5-10-15%; O_2 >12%
- Storage temperature of 1°C, duration 21 days
- Recommendation: automatically ventilated reefer may be set to a maximum limit of **15% CO_2** and a lower limit of **2% O_2**

	Mean moisture loss (%)
Treatment	
AirEx	6.854 a[1]
5-10-15% CO_2	4.738 b
Product	
Grandiceps	3.966 [ns]
Didi	6.315
Ice Queen	6.294
Barbigera 1	5.415
Barbigera 2	6.986
Effect	P value
Product	0.085 ns
Treatment	0.004
Product × treatment	0.127 ns

[1]Mean separation was done by LSD (5%); means with different letters are significantly different from each other; ns shows no significance difference at the 5% confidence level.





Impact of ethylene on postharvest quality

The University of Queensland
Australia

Scientia Horticulturae 230 (2018) 149–154

ELSEVIER

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

An investigation of ethylene sensitivity in three Australian native cut flower genera, *Calothamnus*, *Grevillea* and *Philotheca*

Virginia G. Williamson[a,*], Farhad Rezvani[a], Gen Li[a], Graham Hepworth[b]

[a] School of Ecosystem and Forest Sciences, The University of Melbourne, 500 Yarra Boulevard, Richmond, Victoria 3121, Australia
[b] Statistical Consulting Centre, The University of Melbourne, Victoria, 3010, Australia

Grevillea 'Superb'
'Superb' Grevillea

Vase life and senescence symptoms of *Grevillea* 'Superb'.

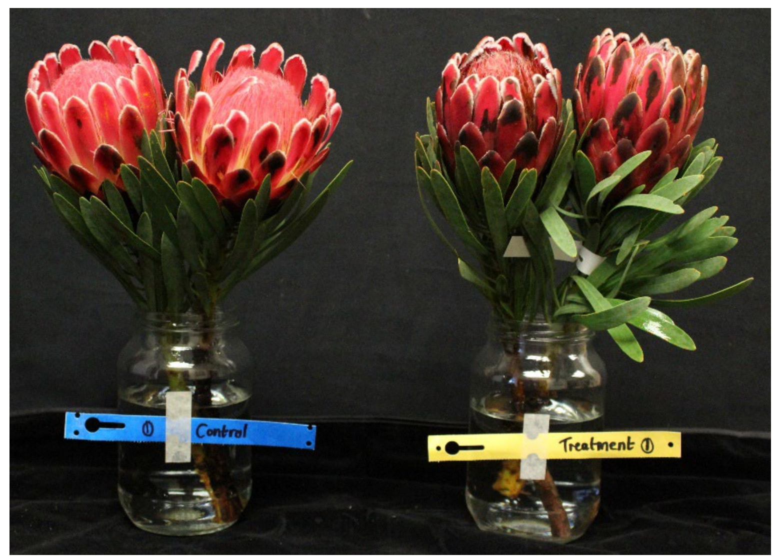
Treatment	Vase life (d) ± SE	Range (d)	Senescence symptoms
Control	7^{b} ± 0.39	4–8	Flower wilting, colour change from salmon to brown, abscission.
Ethylene for 12h	6^{b} ± 0.61	4–8	Abscission prior to wilting or colour change.
1-MCP & then ethylene for 12 h	5.6^{b} ± 0.52	4–9	Flower wilting, colour change from salmon to brown, abscission.
Ethylene & 1-MCP at same time for 12 h	5.7^{b} ± 0.47	4–8	Flower wilting, colour change from salmon to brown, abscission.
STS & then ethylene for 12 h	10^{a} ± 0.39	7–11	Flower wilting but no abscission, colour change from salmon to brown.

Vase life is the mean of 10 replicates; SE = standard error.
Numbers followed by the same letter are not significantly different from each other ($p < 0.05$).

- Only G. 'Superb' benefitted from the ethylene protectant, STS.
- STS significantly prolonged vase life for this species
- G. 'Superb' appeared to not be ethylene-sensitive,
- The benefits of STS may perhaps be because of an ionic effect in the vase solution provided by the Na+ as part of the STS pulse.

Impact of ethylene on postharvest quality

Exposure of *Protea* 'Venus' to 2ppm ethylene gas for 24h

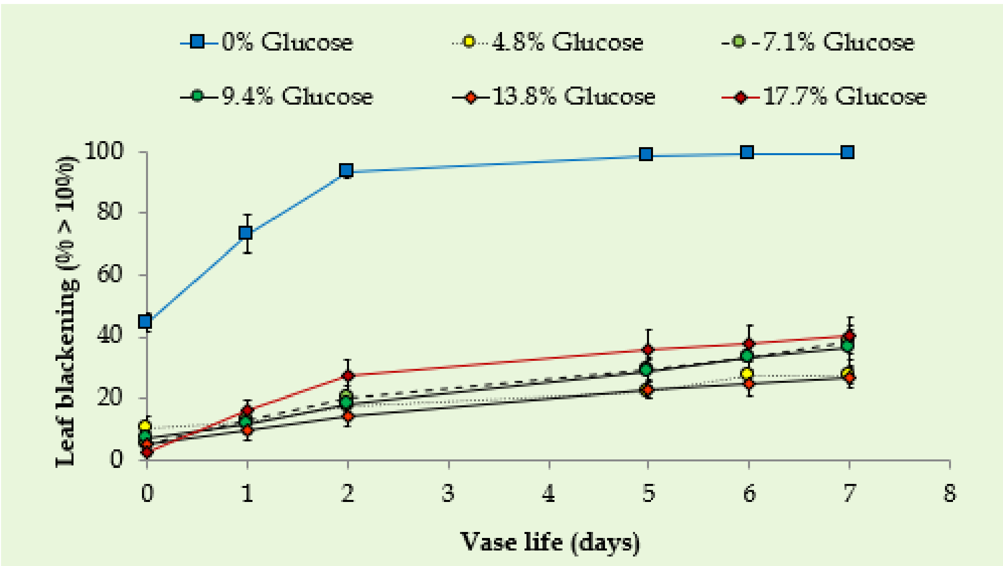


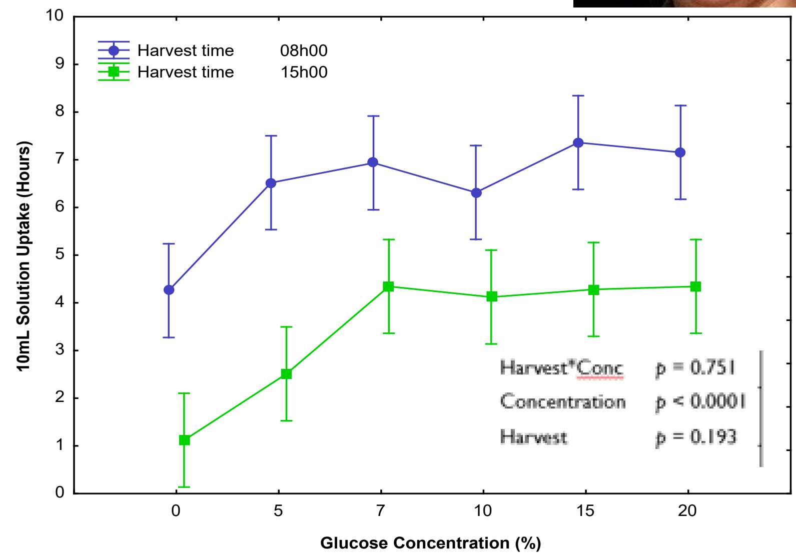
Managing postharvest quality by glucose pulsing

Pulsing with glucose can reduce/control leaf blackening, but not eradicate it

Nicole Windell

LB after 10 days fresh evaluation





Managing postharvest quality by glucose pulsing

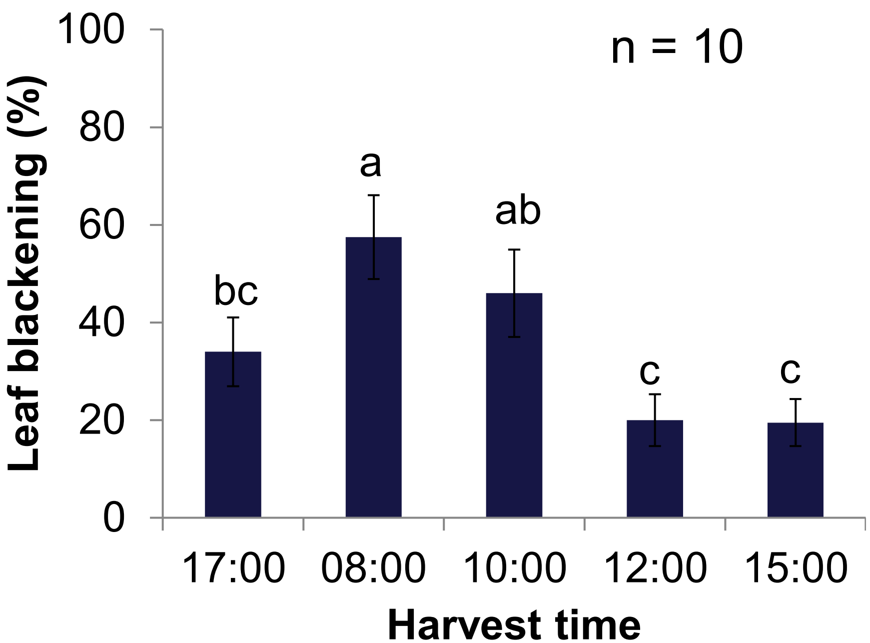
THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Pulsing with glucose can reduce/control leaf blackening, but not eradicate it

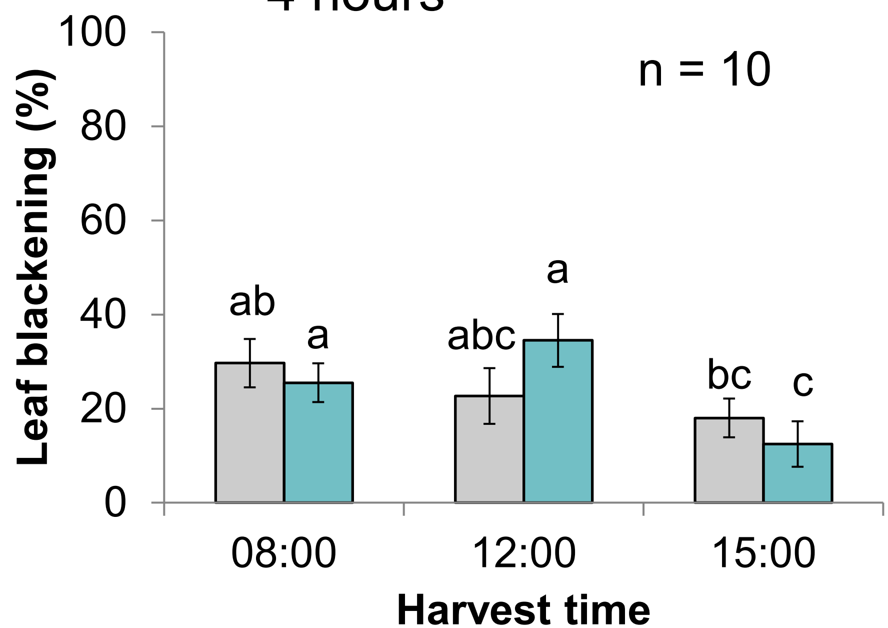
LB after 10 days
fresh evaluation

Nicole Windell

- No pulsing



- Pulsed (6% glucose)
  - 4 hours



THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Addition of a low glucose containing preservative in vase life is beneficial both leaf and flower quality in *Protea*

VASE LIFE (DAY 0)				
Trial	Glucose pulse concentration (%)		Leaf blackening (%)	Flower quality (score)
Sept 2010	0		75.8 a	3.3 b
	10		9.4 b	4.8 a
ANOVA	F		53.482	13.953
	p		<0.0001	<0.0001

VASE LIFE (DAY 7)				
Trial	Glucose pulse concentration (%)	Vase holding solution	Leaf blackening (%)[y]	Flower quality (score)
Sept 2010	0	H_2O	100.0 a	1.0 d
	0	CCProf3	100.0 a	1.0 d
	10	H_2O	35.8 b	2.8 c
	10	CCProf3	22.5 c	4.3 a
ANOVA	F		52.298	36.887
	p		<0.0001	<0.0001

Nicole Windell

- **6% glucose can reduce leaf blackening significant**
- **But it may take too long to take up the glucose pulse solution under commercial conditions**
- **Harvest later in the day assist with better uptake of pulsing solution**

Inclusion of sugars as a pulse/ vase life combination was beneficial for *Leucadendron*

Philosoph-Hadas et al. 2010,
Acta Hort 869:207-217

A. 8 Day Sea Transport Simulation

Pulsing Sugar	Vase Sugar	% Damage 10 Days	% Damage 13 Days
-	-	70	100
Glucose 5%	-	50	80
Glucose 5%	Glucose 2%	30	90
Glucose 5%	Sucrose 2%	0	0
Sucrose 5%	-	70	90
Sucrose 5%	Glucose 2%	40	80
Sucrose 5%	Sucrose 2%	30	90

B. 21 Day Sea Transport Simulation

Pulsing Sugar	Vase Sugar	% Damage 4 Days	% Damage 11 Days
-	-	50	100
Glucose 5%	-	0	70
Glucose 5%	Glucose 2%	0	90
Glucose 5%	Sucrose 2%	0	90
Sucrose 5%	-	0	30
Sucrose 5%	Glucose 2%	0	100
Sucrose 5%	Sucrose 2%	30	100

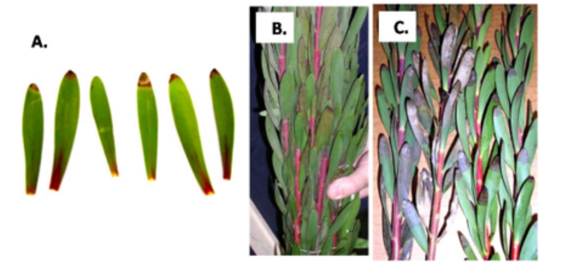
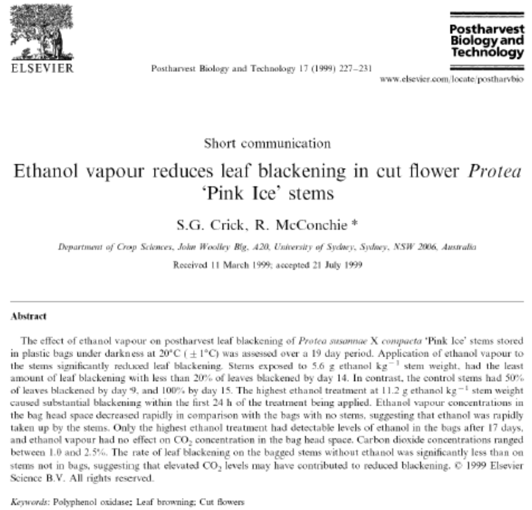


Fig. 1. Desiccation of leaf tips (A) and the appearance of leaf blackening in *Leucadendron* 'Safari Sunset' branches following sea transport of 8 days to Europe (B) and 21 days to USA (C).

The use of ethanol vapour or pulsing to reduce leaf blackening

Nicole Windell



ELSEVIER

Postharvest Biology and Technology 17 (1999) 227–231

Postharvest Biology and Technology

www.elsevier.com/locate/postharvbio

Short communication

Ethanol vapour reduces leaf blackening in cut flower *Protea* 'Pink Ice' stems

S.G. Crick, R. McConchie *

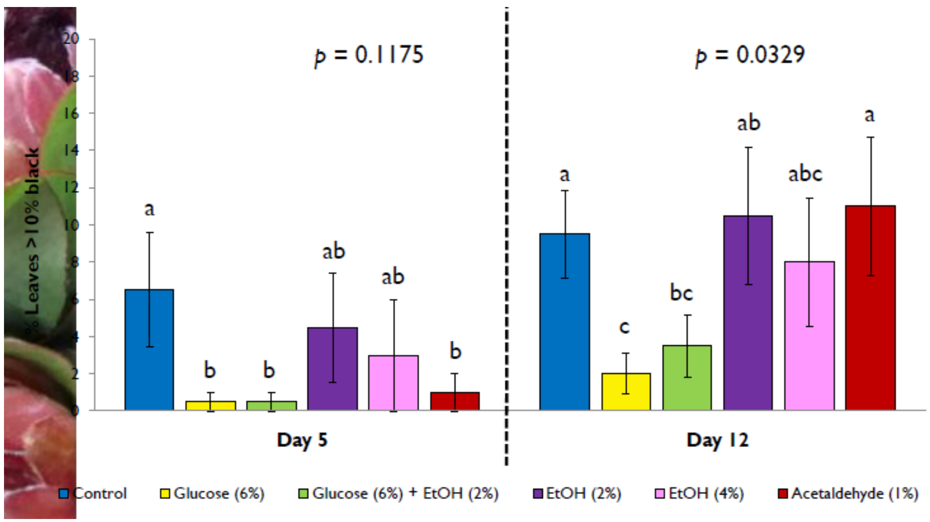
Department of Crop Sciences, John Woolley Blg, A20, University of Sydney, Sydney, NSW 2006, Australia

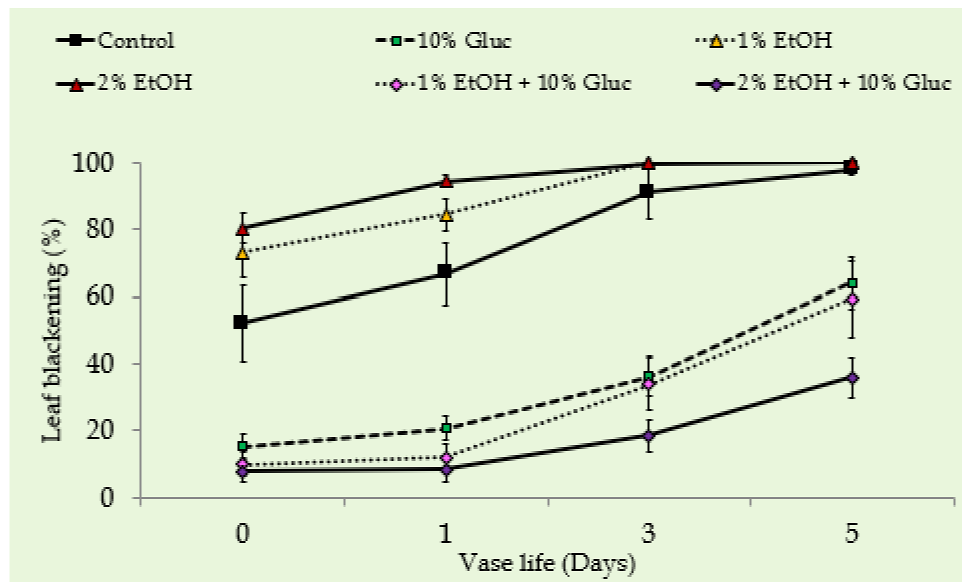
Received 11 March 1999; accepted 21 July 1999

Abstract

The effect of ethanol vapour on postharvest leaf blackening of *Protea susannae* X *compacta* 'Pink Ice' stems stored in plastic bags under darkness at 20°C (±1°C) was assessed over a 19 day period. Application of ethanol vapour to the stems significantly reduced leaf blackening. Stems exposed to 5.6 g ethanol kg^{-1} stem weight, had the least amount of leaf blackening with less than 20% of leaves blackened by day 14. In contrast, the control stems had 50% of leaves blackened by day 9, and 100% by day 15. The highest ethanol treatment at 11.2 g ethanol kg^{-1} stem weight caused substantial blackening within the first 24 h of the treatment being applied. Ethanol vapour concentrations in the bag head space decreased rapidly in comparison with the bags with no stems, suggesting that ethanol was rapidly taken up by the stems. Only the highest ethanol treatment had detectable levels of ethanol in the bags after 17 days, and ethanol vapour had no effect on CO_2 concentration in the bag head space. Carbon dioxide concentrations ranged between 1.0 and 2.5%. The rate of leaf blackening on the bagged stems without ethanol was significantly less than on stems not in bags, suggesting that elevated CO_2 levels may have contributed to reduced blackening.

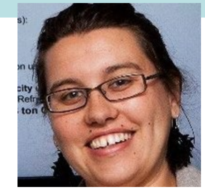
Keywords: Polyphenol oxidase; Leaf browning; Cut flowers





The role of stomata in maintain postharvest quality of pulsed *Protea* stems

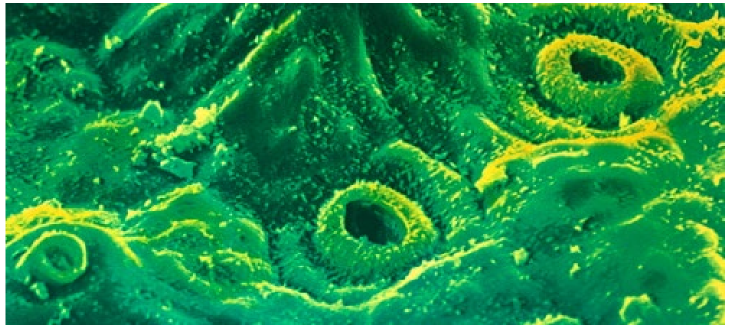
Nicole Windell



Original Article | Full Access

Stomatal malfunctioning under low VPD conditions: induced by alterations in stomatal morphology and leaf anatomy or in the ABA signaling?

Sasan Aliniaeifard, Priscila Malcolm Matamoros, Uulke van Meeteren

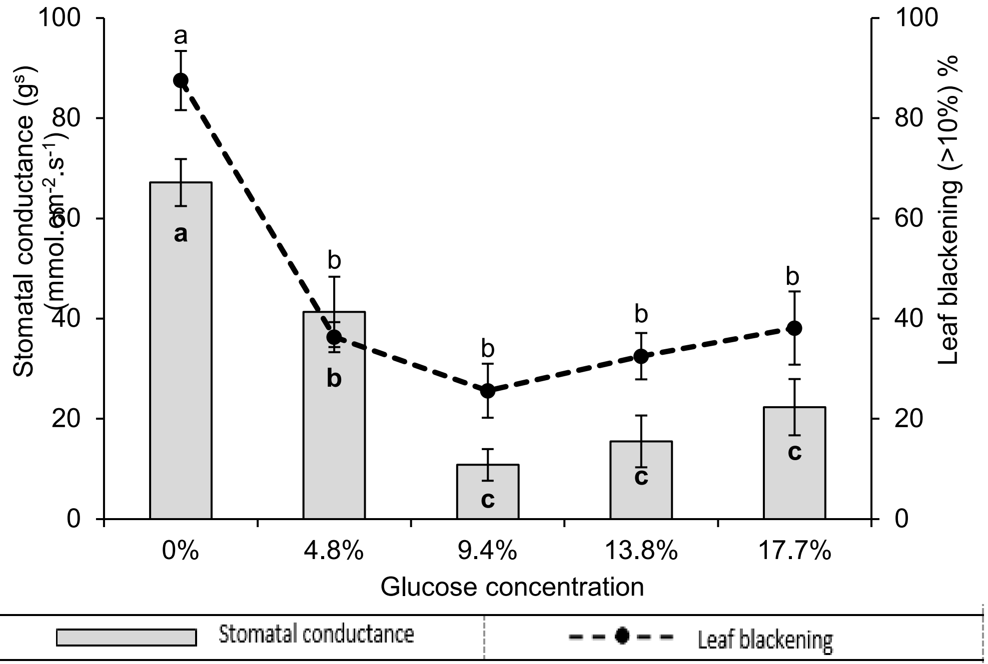


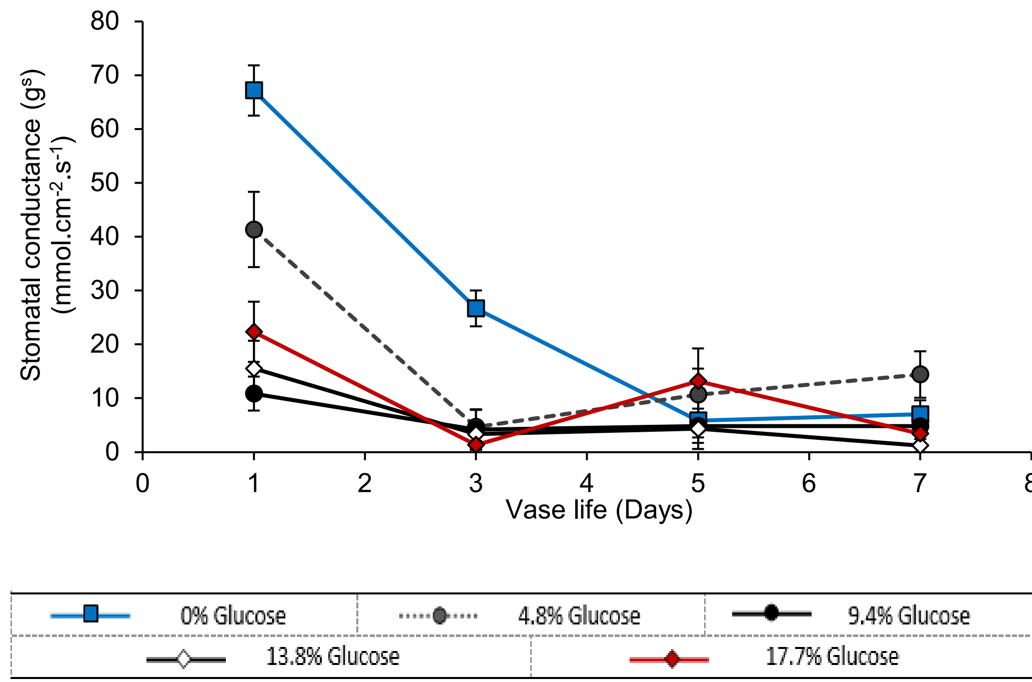
Eur. J. Hortic. Sci. 84(4), 245–252 | ISSN 1611-4426 print, 1611-4434 online | https://doi.org/10.17660/eJHS.2019/84.4.7 | © ISHS 2019

Original article

Low air humidity during cultivation promotes stomatal closure ability in rose

D. Fanourakis[1], H. Giday[2,3], B. Hyldgaard[2,4], D. Bouranis[5], O. Körner[6,7] and C.-O. Ottosen[2]





Long-term cold storage of potted *Protea* ornamentals & the role of stomatal control

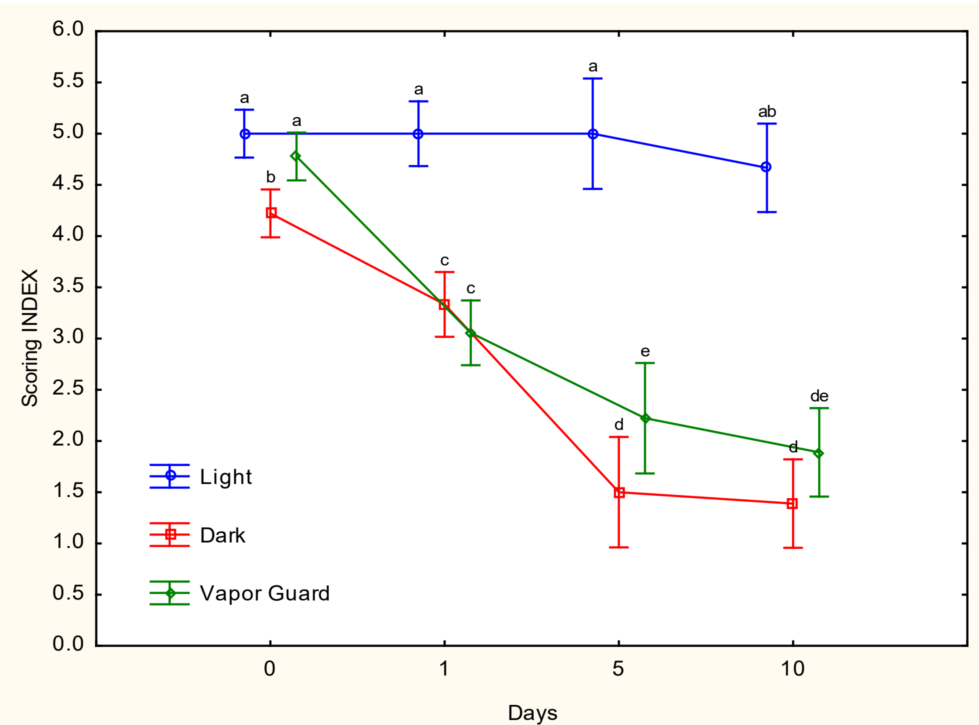
Madelein De Klerk

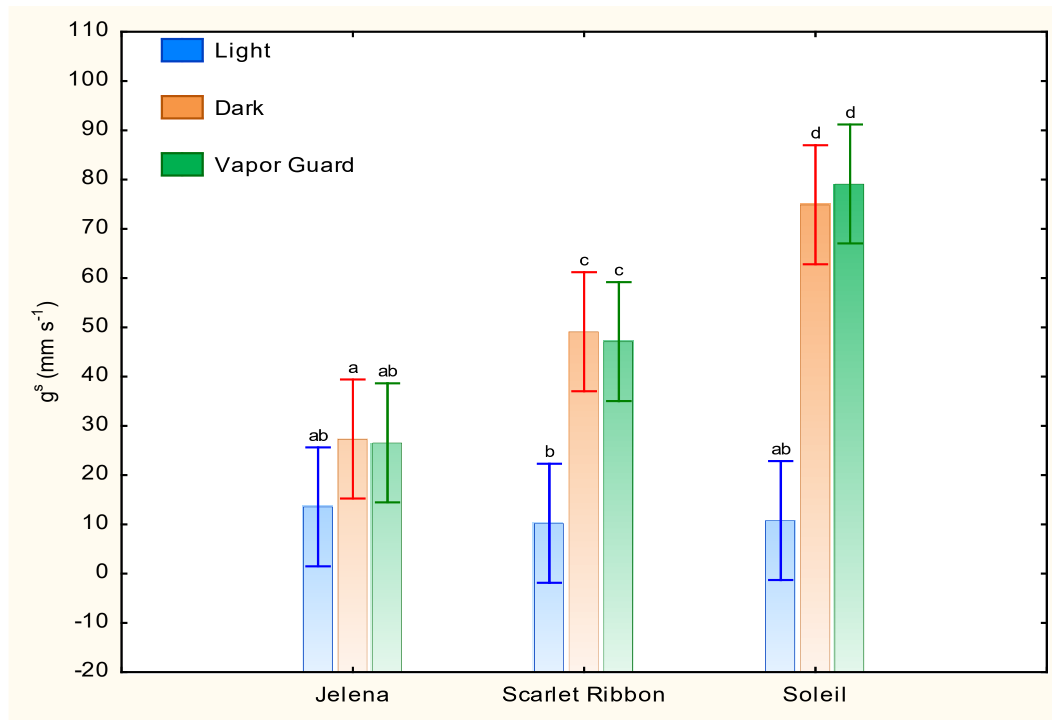
Storage treatments

Control: storing 9 plants (3x3) at 100% RH at 6˚C dark conditions

Vapour Guard^{R}: Anti-transpirant spray, stored similar to control

Light: 60–70% RH, in a growth chamber, at 6˚C, light at ±30-40μmol.m^{-2}.s^{-1}.





Long-term cold storage of ornamentals & the role of low light levels

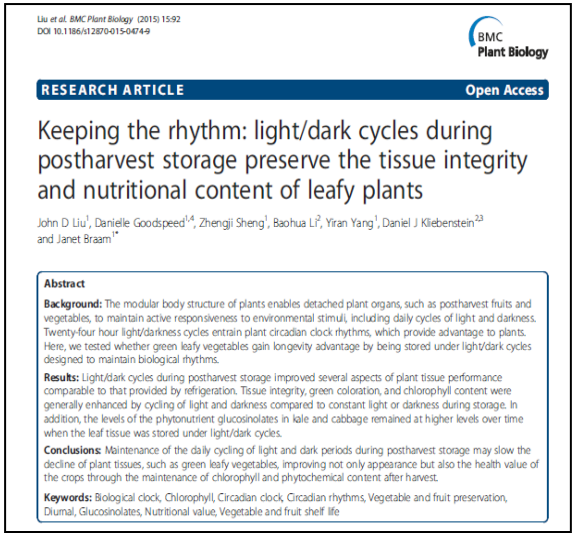
Exporting of *Leucospermum* potted plants?

?

?

?

Special potential – Unique, showy & hardy



Liu *et al. BMC Plant Biology* (2015) 15:92
DOI 10.1186/s12870-015-0474-9

BMC Plant Biology

RESEARCH ARTICLE Open Access

Keeping the rhythm: light/dark cycles during postharvest storage preserve the tissue integrity and nutritional content of leafy plants

John D Liu[1], Danielle Goodspeed[1,4], Zhengji Sheng[1], Baohua Li[2], Yiran Yang[1], Daniel J Kliebenstein[2,3] and Janet Braam[1*]

Abstract

Background: The modular body structure of plants enables detached plant organs, such as postharvest fruits and vegetables, to maintain active responsiveness to environmental stimuli, including daily cycles of light and darkness. Twenty-four hour light/darkness cycles entrain plant circadian clock rhythms, which provide advantage to plants. Here, we tested whether green leafy vegetables gain longevity advantage by being stored under light/dark cycles designed to maintain biological rhythms.

Results: Light/dark cycles during postharvest storage improved several aspects of plant tissue performance comparable to that provided by refrigeration. Tissue integrity, green coloration, and chlorophyll content were generally enhanced by cycling of light and darkness compared to constant light or darkness during storage. In addition, the levels of the phytonutrient glucosinolates in kale and cabbage remained at higher levels over time when the leaf tissue was stored under light/dark cycles.

Conclusions: Maintenance of the daily cycling of light and dark periods during postharvest storage may slow the decline of plant tissues, such as green leafy vegetables, improving not only appearance but also the health value of the crops through the maintenance of chlorophyll and phytochemical content after harvest.

Keywords: Biological clock, Chlorophyll, Circadian clock, Circadian rhythms, Vegetable and fruit preservation, Diurnal, Glucosinolates, Nutritional value, Vegetable and fruit shelf life

Morgana Miller

Light trt

Two three-tiered Danish potted plant trolleys

Lowest level = 'Full light treatment'.

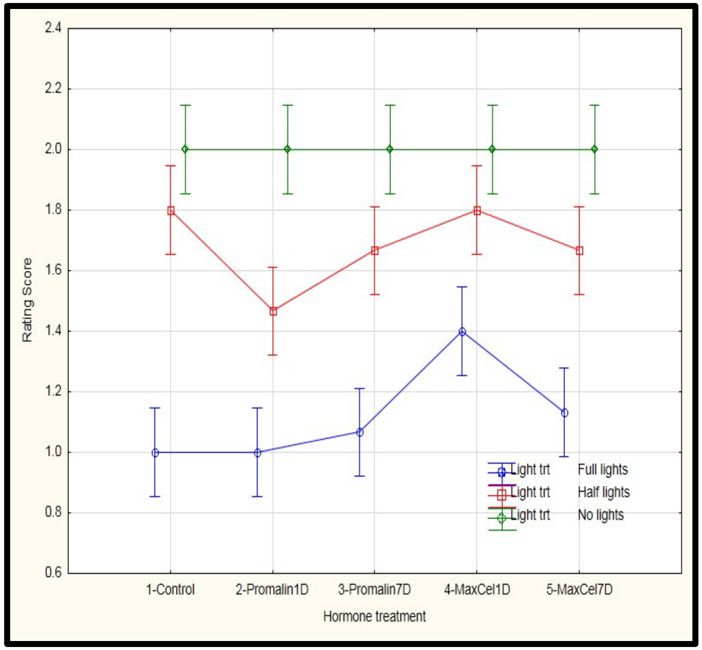
Middle level = 'Half light' treatment.

Top level = 'No light' treatment.

Ribbons of blue and deep red LED lights used. PAR 25.03±2.09 µmol.m^{-1}.s^{-1}

Blue = 450nm; Deep red = 700nm.

PGR trt: promalin (BA/GA$_{4\&7}$) & BA (500 ppm); applied 1 or 7 days prior to harvest



Alternatives to glucose/ ethanol for pulsing?

Waafeka Vardien

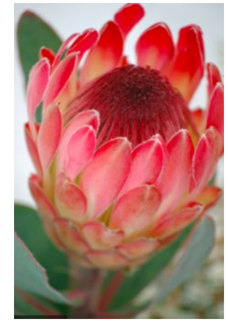
- <u>Sugars/ osmolytes/antioxidants:</u> Trehalose, glycine betaine, lactulose, ascorbic acid
- <u>Invertase inhibitors:</u> cycloheximide and chloramphenicol


Scientia Horticulturae

Volume 198, 26 January 2016, Pages 52-60

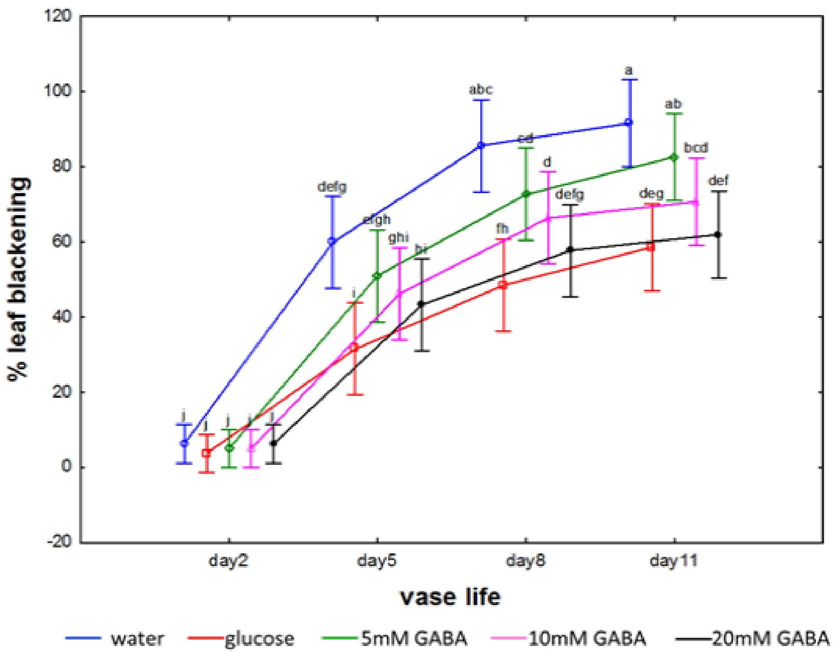
Enhancement of postharvest chilling tolerance of anthurium cut flowers by γ-aminobutyric acid (GABA) treatments

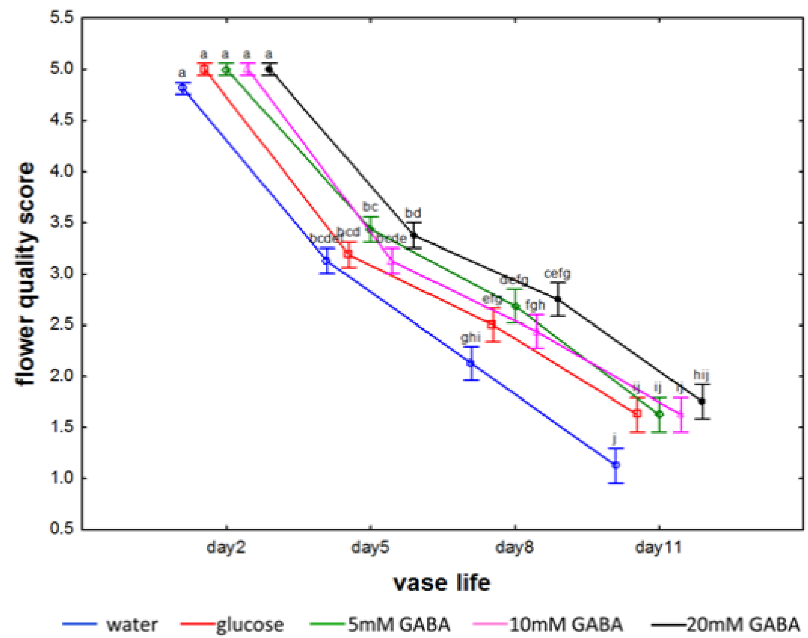
Morteza Soleimani Aghdam [a], Roohangiz Naderi [a], Abbasali Jannatizadeh [b], Mohammad Ali Askari Sarcheshmeh [a], Mesbah Babalar [a]



GABA: γ-Aminobutyric acid

- <u>Leaf blackening decreases</u> with <u>increasing concentrations of GABA</u> in 'Sylvia'
- But the effect of the glucose is more significant to control blackening.





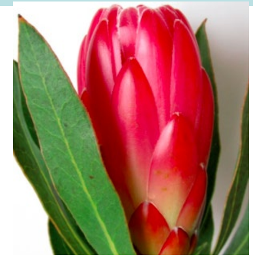
Alternatives to glucose/ ethanol for pulsing?

Sodium nitroprusside

Is nitric oxide a critical key factor in ABA-induced stomatal closure?

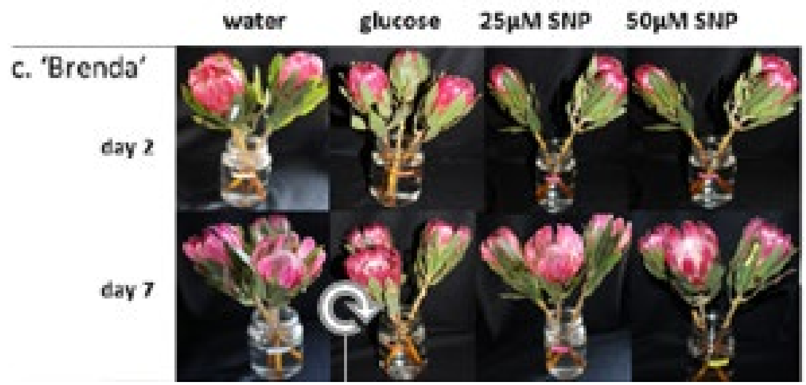
Uulke Van Meeteren, Elias Kaiser, Priscila Malcolm Matamoros, Julian C Verdonk, Sasan Aliniaeifard

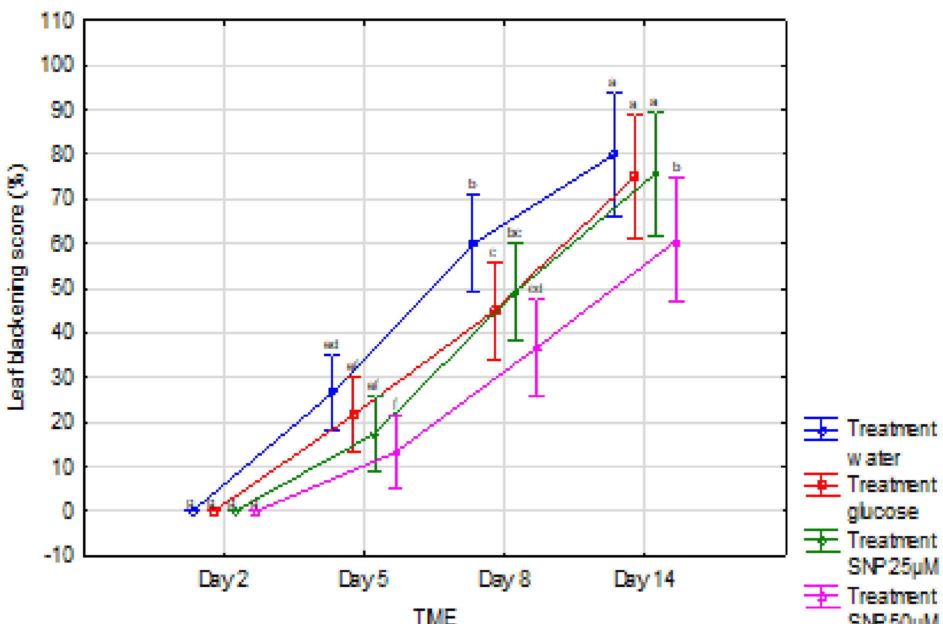
Journal of Experimental Botany, Volume 71, Issue 1, 1 January 2020, Pages 399–410,
https://doi.org/10.1093/jxb/erz437
Published: 30 September 2019

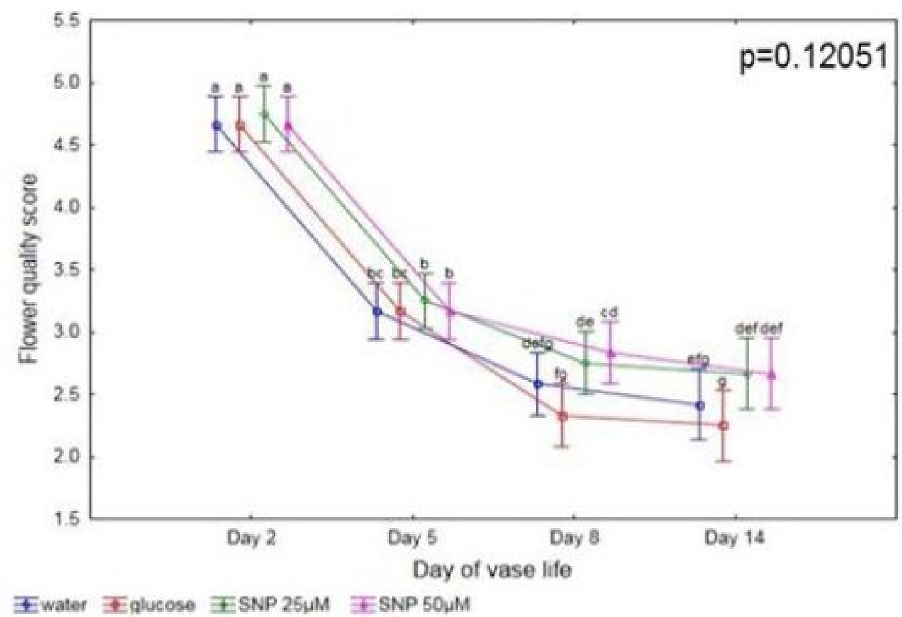


Waafeka Vardien

The variation in percentage (%) leaf blackening & flower quality in ‘Brenda’ over a vase life period of 14 days, for stems pulsed with 6% glucose, 25 and 50 μM sodium nitroprusside.



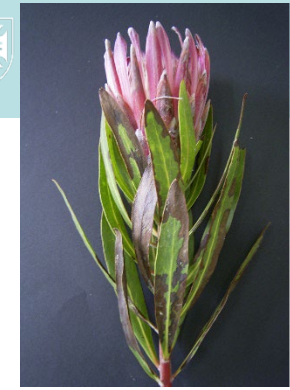




Alternatives to glucose/ ethanol for pulsing?

Ascorbic Acid Antioxidant Activity against Leaf Blackening of *Protea*

M. Hernández, C.E. Álvarez and M. Fernández-Falcón
Instituto de Productos Naturales y Agrobiología,
Consejo Superior de Investigaciones Científicas,
Avda. Astrofísico Francisco Sánchez, N°3, 38206
La Laguna, Tenerife, Spain



13 days vase life

8 days vase life

Control- no treatment

Sprayed with 5g/L ascorbic acid, water as vase solution

5g/L ascorbic acid as vase solution

'Pink Ice' inflorescences are shown eight days after harvest. The control, where stems were placed in a water vase solution is displayed on the left; a flowering stem from the treatment (T2) which was sprayed with a 5g.L^{-1} ascorbic acid, but was held in a water vase solution is shown in the centre, whilst a stem which was left unsprayed, but was held in a 5g.L^{-1} ascorbic acid vase solution throughout vase life is shown on the right.

11 days vase life

Sprayed with 5g/L ascorbic acid, water as vase solution

5g/L ascorbic acid as vase solution

'Pink Ice' inflorescences are shown eleven days after harvest. A flowering stem from the treatment (T2) which was sprayed with a 5g.L^{-1} ascorbic acid, but was held in a water vase solution is shown on the left, whilst a stem which was left unsprayed (T1), but was held in a 5g.L^{-1} ascorbic acid vase solution throughout vase life is shown on the right.

Using CATTs for phytosanitary pest control as required for exports

(Controlled atmosphere temperature treatment system- atmosphere of 1% O_2, 15% CO_2 in N_2)

Treated cut flowers: Barbi and Sylvia

TBZ- Thiabendazole

Pre-treatment

1. Spray leaves with 2% TBZ
2. Control 1: No TBZ & No CATTS
3. Control 2: CATTS only

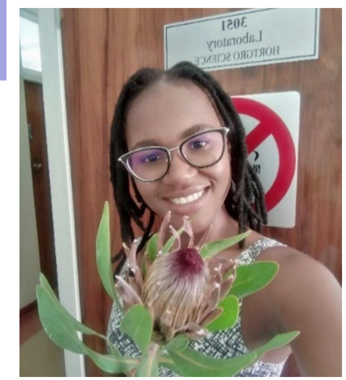
CATTS treatment

1. 35°C/hour temperature
2. Ramp rate from 23°C to 40°C
3. 15 min soaking period at 40°C

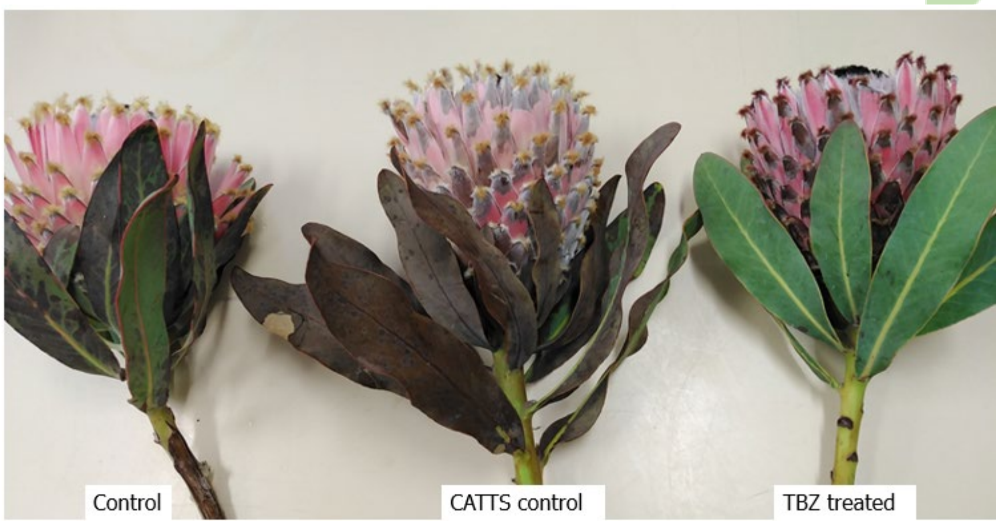
Post treatment

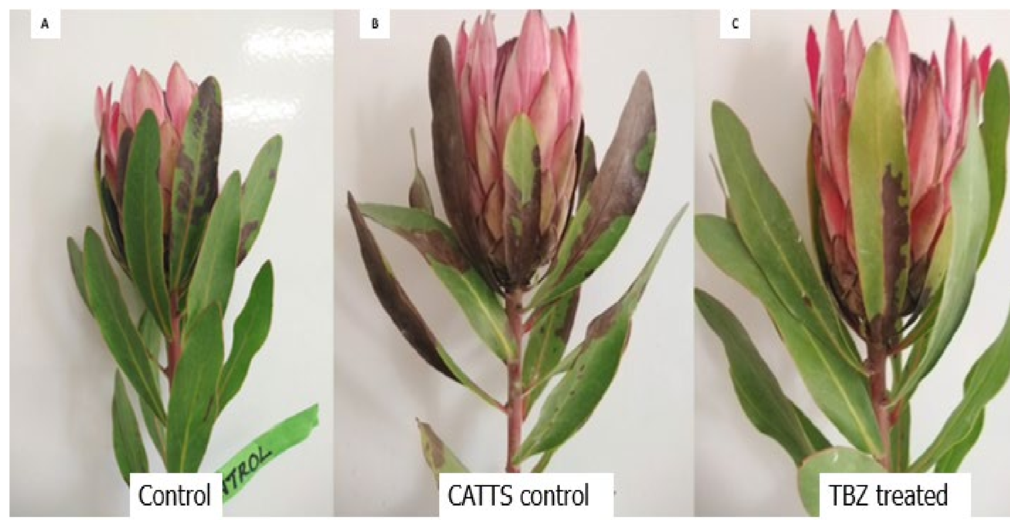
1. Direct evaluations
2. Air freight simulation
3. Sea freight simulation

Western Flower trips



Nkosi Ngwenya





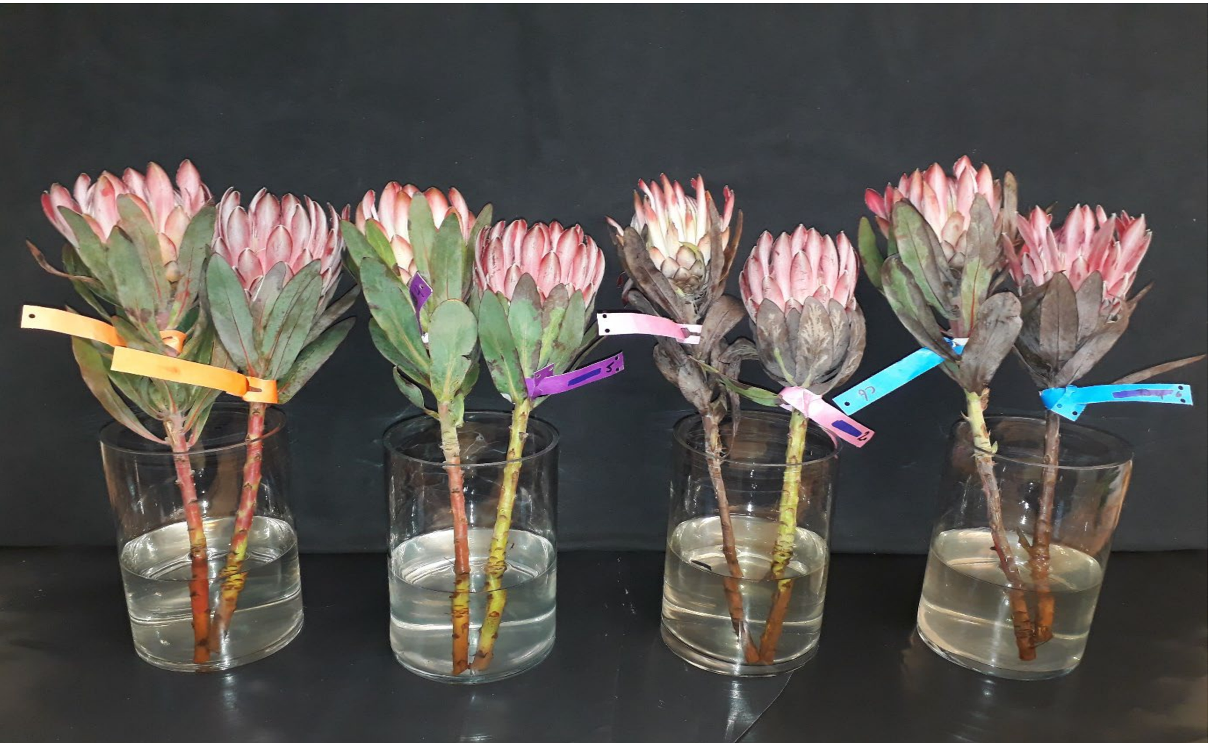
Chrysal Viva (6-Benzyladenine) for leaf blackening control

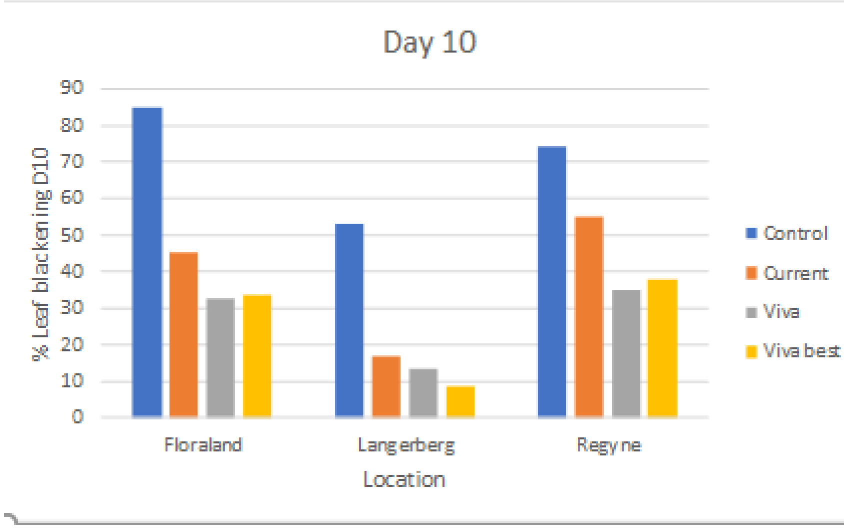
Application: 4ml/ L spray

	Trial 3	Hydrating solution	Post harvest	Retail	Vase
1	Control	water	none	water	water
2	Current	water	none	prof 2	water
3	Viva	water	viva	prof 2	prof 3
4	Best	prof 3	viva	prof 2	prof 3

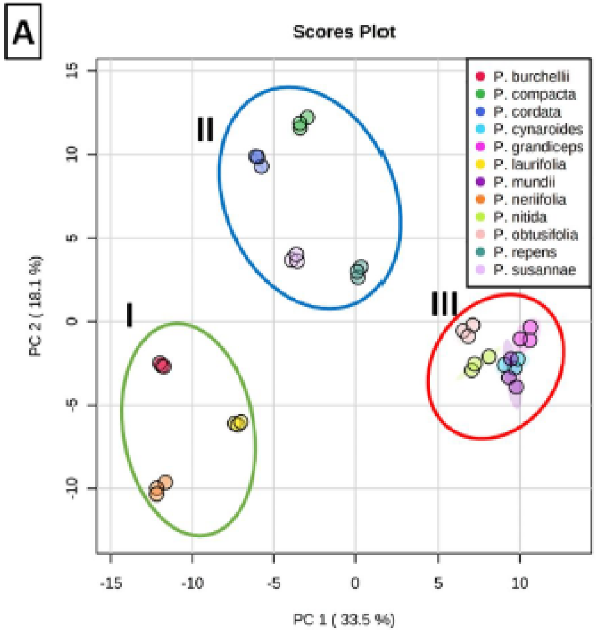
Kimberley van der Vegt

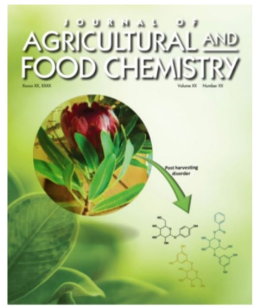
DAY 10 Swellendam

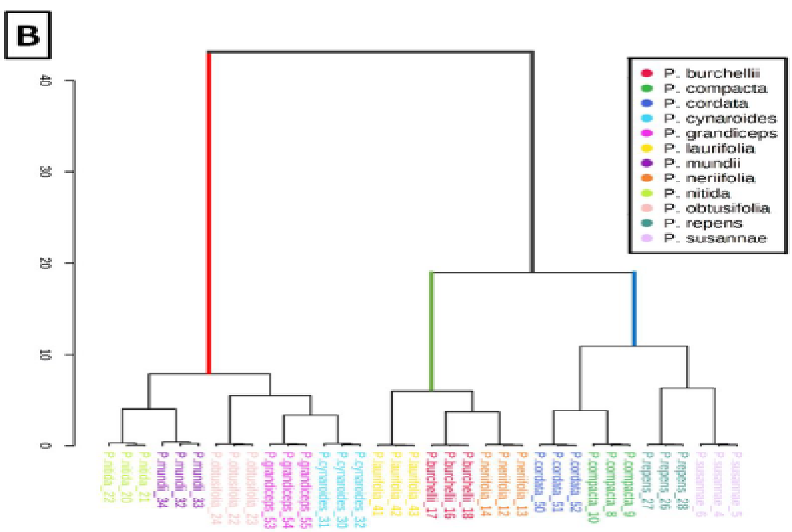




Application of metabolomics tools to determine possible biomarker metabolites linked to leaf blackening in *Protea*







Keabetswe Masike

- Analysed by liquid-chromatography hyphenated to photodiode array and high resolution mass spectrometry (LC-PDA-HRMS),
- where 116 features were annotated from 37 *Protea* species
- Stems susceptible to leaf blackening cluster together and contained features identified as benzenetriol (I) and/or hydroquinone (II) derived metabolites e.g. neriifolin & arbutin
- Species, selections and cultivars not prone to blackening (III) were linked to metabolites with known protective properties against biotic and abiotic stressors such as protocatechuic acid
- During the browning process, resistant cultivars produce high levels of protective metabolites

Postharvest challenges for Proteaceae products

- ✓ To deliver products of consistent high quality with a long vase life
  - research required for new products & cultivars
  - new markets, new requirements
- ✓ To lower carbon footprint of the input chain by
  - using sea freight as opposed to air freight, without sustaining chilling injury
- ✓ Consumer expectations of near-perfect produce, throughout the year
- ✓ To develop new cultivars, less sensitive to leaf blackening

Thank you for your attention