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**The Influence of Lime Sulphur on the Quality and Sulphur Content of
Organic 'Royal Gala' and 'Braeburn' Apples**

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Philosophy

in

Agribusiness

at Massey University, Palmerston North, New Zealand.

Diana Ihringer

2007

"There is only one good, knowledge, and one evil, ignorance."

Socrates (469 BC-399 BC)

"Was man nicht aufgibt, hat man nie verloren."

Friedrich von Schiller (1759-1805)

ABSTRACT

Black spot or apple scab is a major disease in apple (*Malus domestica*) production. Its control is especially difficult in organic production systems that rely on copper- and sulphur-based fungicides which are not very effective and demand a high number of applications throughout the season. The most commonly used fungicide in organic apple production is lime sulphur, which is known to be phytotoxic, especially towards the cultivar 'Braeburn'.

The influence of different application rates of lime sulphur (1% and 2%) was evaluated when applied 11 times throughout the growing season from October to February. As varieties differ in their susceptibility to lime sulphur, the two cultivars 'Royal Gala' and 'Braeburn' were compared in this study. Black spot incidence and severity, russet development and postharvest quality parameters were evaluated. At harvest, residues of sulphur on and in the apple were determined as total sulphur, total water-soluble non-protein thiol compounds and cysteine content.

Both cultivars behaved similarly to the application of lime sulphur, but 'Braeburn' was affected to a greater extent. Lime sulphur decreased background colour, blush, firmness, soluble solids content and dry matter content in both cultivars; fruit size in 'Braeburn' and titratable acidity in 'Royal Gala'. The changes observed can possibly be attributed at least in part to the decrease in the photosynthetic rate, which was especially drastic in 'Braeburn'. Lime sulphur caused increased russet on 'Royal Gala', but not on 'Braeburn'. Significant sulphur residues were found in the skin and flesh of both cultivars and part of the lime sulphur applied was metabolized into water-soluble non-protein thiols and cysteine.

These results are of significant interest to the organic industry as the use of lime sulphur may compromise the residue-free status of organic apples and could have an influence on consumer acceptance and flavour.

ACKNOWLEDGEMENTS

First of all, thanks to my supervisors for their advice throughout the course of this project: Dr Alan Palmer, Mr Ewen Cameron and Dr David Woolley, Institute of Natural Resources, Massey University, Palmerston North. I wish to especially acknowledge the commitment and enthusiasm of Ewen and Alan in setting up this project for me at very short notice and the encouragement I received over the year. The funding for this research from the C.A. Elliot Charitable Trust, Massey University Masterate Scholarship and Helen E. Akers Postgraduate Scholarship is greatly appreciated.

Dr Jim Walker, Dr Stuart Tustin and Dr Paul Brookfield of HortResearch, Havelock North gave advice in setting up this project and discussing the results; Dr Roger Harker, HortResearch, Auckland took the time to discuss the flavour of apples with me and Prof. Dr Jens Wuensche, University of Hohenheim, Stuttgart, Germany gave valuable input on the trial design. Thank you all!

I am very grateful to Anne West and Dr Alasdair Noble for their help with the statistical analysis. My little helpers took care of the orchard, applied the sprays, did the fruit thinning and helped me pick, wash, peel and pack hundreds of apples: Steven Ray, Chris Clement, Scott Avery, Frazer Clarke, Louis Irving, James Slater, Esther Anderson, Heather Richardson, and Catherine, Mark and Rosalie Sykes. Thank you! I am grateful to Kathleen Bailey who helped with the analysis of total thiols and cysteine. Special thanks to everyone in the department, especially Denise Stewart, and to Bob Toes, Ian Furkert and Chris Rawlingson for their help with the lab work. Thanks to Linda Hill and Brian Daly of Landcare, Palmerston North who spend a lot of time trying to get the LECO to work.

Last, but definitely no least, I am greatly indebted to my mother for her encouragement and financial support. A big thank you to my brother Stefan for editing the pictures.

TABLE OF CONTENTS

ABSTRACT	III
ACKNOWLEDGEMENTS	IV
TABLE OF CONTENTS	V
LIST OF FIGURES	IX
LIST OF TABLES	XI
LIST OF ABBREVIATIONS	XIII
CHAPTER 1	
INTRODUCTION	1
1.1 Organics	1
1.2 Black Spot and Lime Sulphur	2
1.3 Problem Statement	3
1.4 Research Objectives	4
CHAPTER 2	
REVIEW OF THE LITERATURE	6
2.1 Black Spot	6
2.1.1 Pathogen	6
2.1.2 Disease Symptoms	8
2.1.3 Control Strategies	9

2.2 Pre- and Postharvest Physiology.....	14
2.2.1 Influence of Lime Sulphur on Plants.....	14
2.2.2 Fruit Quality Parameters.....	17
2.2.3 Influence of Lime Sulphur on Fruit Quality.....	19
2.3 Uptake of Atmospheric Sulphur by Plants	20
2.4 Summary	21
 CHAPTER 3	
MATERIALS AND METHODS.....	23
3.1 Orchard and Equipment.....	23
3.2 Trial Layout.....	23
3.3 Spray Applications	24
3.4 Photosynthesis	27
3.5 Sampling Procedure and Sample Preparation.....	27
3.6 Sulphur	28
3.6.1 Total Sulphur.....	28
3.6.2 Thiols and Cysteine	28
3.7 Black Spot	30
3.8 Russet.....	31
3.9 Postharvest Quality.....	32
3.9.1 Size.....	32
3.9.2 Colour.....	32
3.9.3 Firmness.....	33
3.9.4 Soluble Solids Content.....	33
3.9.5 Starch Pattern Index.....	33
3.9.6 Titratable Acidity	34
3.9.7 Dry Matter	34
3.10 Statistical Analysis.....	34

CHAPTER 4

RESULTS	35
4.1 Photosynthesis	35
4.2 Sulphur	36
4.2.1 Total Sulphur.....	36
4.2.2 Thiols and Cysteine	37
4.3 Black Spot	39
4.4 Russet	40
4.5 Postharvest Quality	41
4.5.1 Size.....	41
4.5.2 Colour.....	43
4.5.3 Firmness.....	45
4.5.4 Soluble Solids Content.....	46
4.5.5 Starch Pattern Index.....	47
4.5.6 Titratable Acidity	48
4.5.7 Dry Matter	49

CHAPTER 5

DISCUSSION	50
5.1 Photosynthesis	50
5.2 Sulphur	53
5.3 Black Spot	59
5.4 Russet	60
5.5 Postharvest Quality	61
5.5.1 Size.....	61
5.5.2 Colour.....	62
5.5.3 Firmness.....	65
5.5.4 Soluble Solids Content.....	66

5.5.5 Starch Pattern Index.....	67
5.5.6 Titratable Acidity	68
5.5.7 Dry Matter	68
5.6 Summary	69
CHAPTER 6	
CONCLUSIONS AND FUTURE WORK.....	71
6.1 Future Research Possibilities.....	71
6.1.1 Alternatives to Lime Sulphur.....	71
6.1.2 Fruit Quality	71
6.1.3 Spray Schedules.....	72
6.2 Concluding Remarks	73
BIBLIOGRAPHY	75
APPENDIX	
A: TRANSFORMED POSTHARVEST QUALITY DATA.....	88
A.1 Weight	88
A.2 Diameter.....	89
A.3 Blush	89
A.4 Firmness.....	90
A.5 Titratable Acidity	91
A.6 Dry Matter.....	91
B: TOTAL SULPHUR ANALYSIS	92
C: CLIMATIC DIFFERENCES: MANAWATU AND HAWKE'S BAY	94

LIST OF FIGURES

CHAPTER 2

2.1 The life cycle of the black spot fungus <i>Venturia inaequalis</i>	7
2.2 Lesions caused by black spot on apple leaves and fruit.....	8

CHAPTER 3

3.1 Orchard set-up	24
3.2 Movable curtains were installed between rows to guard against spray drift	24
3.3 Rating scale for black spot severity on 'Royal Gala' from 0 (no black spot) to 5 (severe infection)	30
3.4 Rating scale for black spot severity on 'Braeburn' from 0 (not black spot) to 3 (black spot patches).....	30
3.5 Rating scale for russet on 'Royal Gala' from 0 (no russet) to 4 (severe russet).....	31
3.6 Rating scale for russet on 'Braeburn' from 0 (no russet) to 3 (high stem end russet).....	31
3.7 Rating for colour of 'Royal Gala' and 'Braeburn' using colour swatches.....	32
3.8 Rating for starch pattern index from 0 (all starch) to 6 (no starch)	33

CHAPTER 4

4.1 Calibration curve for analysis of total water-soluble non-protein thiols and cysteine.....	37
4.2 Percentage of 'Royal Gala' affected with black spot at harvest	40
4.2 Percentage of 'Royal Gala' unfit for marketing due to excessive russet at harvest.....	41

CHAPTER 5

5.1 Damage caused by lime sulphur to 'Braeburn' leaves	52
5.2 Sulphur metabolized into total water-soluble non-protein thiols and cysteine in skin and flesh of 'Royal Gala' at harvest.....	55
5.3 Sulphur metabolized into total water-soluble non-protein thiols and cysteine in skin and flesh of 'Braeburn' at harvest.....	56
5.4 'Royal Gala' apples severely affected by russet in treatment LS2.....	61
5.5 In 'Braeburn', a high application of 2% lime sulphur led to a decreased fruit size, different shape, lower background colour, reduced blush percentage and a less intense red compared to the control	64

APPENDIX

B.1 Comparison of total sulphur measurements obtained with the LECO and ICP-OES for 'Braeburn' flesh samples in the first harvest.....	93
C.1 Mean annual temperature in New Zealand.....	95
C.2 Mean annual sunshine hours in New Zealand.....	96
C.3 Mean annual rainfall in New Zealand.....	97
C.4 Mean monthly rainfall and temperature in Palmerston North, Manawatu.....	98
C.5 Mean monthly rainfall and temperature in Napier, Hawke's Bay.....	98

LIST OF TABLES

CHAPTER 3

3.1 Spray diary for 2006/07 season on 'Royal Gala' and 'Braeburn'	26
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CHAPTER 4

4.1 Photosynthetic rate of 'Royal Gala' and 'Braeburn' on two days in late season	35
4.2 Total sulphur content of 'Royal Gala' and 'Braeburn' in the first harvest	36
4.3 Sulphur metabolized into total water-soluble non-protein thiols of 'Royal Gala' and 'Braeburn' in the first harvest.....	38
4.4 Sulphur metabolized into cysteine of 'Royal Gala' and 'Braeburn' in the first harvest.....	38
4.5 Percentage of 'Royal Gala' and 'Braeburn' in each black spot category on a scale from 0 (no black spot) to 5 (severe black spot)	39
4.6 Percentage of 'Royal Gala' and 'Braeburn' in each russet category on a scale from 0 (no russet) to 4 (severe russet)	40
4.7 Weight of 'Braeburn'	41
4.8 Diameter of 'Braeburn'	42
4.9 Weight of 'Royal Gala'	42
4.10 Diameter of 'Royal Gala'	42
4.11 Background colour rating in 'Royal Gala'	43
4.12 Background colour rating in 'Braeburn'	43
4.13 Percentage of surface area blushed on 'Royal Gala'	44
4.14 Percentage of surface area blushed on 'Braeburn'	44
4.15 Flesh firmness in 'Royal Gala'	45
4.16 Flesh firmness in 'Braeburn'	45
4.17 Soluble solids content in 'Royal Gala'	46
4.18 Soluble solids content in 'Braeburn'	46

4.19 Starch pattern index in 'Royal Gala'.....	47
4.20 Starch pattern index in 'Braeburn'	47
4.21 Titratable acidity in 'Royal Gala'.....	48
4.22 Titratable acidity in 'Braeburn'.....	48
4.23 Dry matter content of 'Royal Gala' and 'Braeburn'.....	49

APPENDIX

A.1 Transformed weight data for 'Royal Gala'.....	88
A.2 Transformed weight data for 'Braeburn'.....	88
A.3 Transformed diameter data for 'Royal Gala'.....	89
A.4 Transformed diameter data for 'Braeburn'.....	89
A.5 Transformed blush data for 'Royal Gala'.....	89
A.6 Transformed blush data for 'Braeburn'.....	90
A.7 Transformed firmness data for 'Royal Gala'.....	90
A.8 Transformed firmness data for 'Braeburn'.....	90
A.9 Transformed titratable acidity data for 'Royal Gala'.....	91
A.10 Transformed titratable acidity data for 'Braeburn'.....	91
A.11 Transformed dry matter data for 'Royal Gala' and 'Braeburn'.....	91

LIST OF ABBREVIATIONS

amf	acid milliequivalent factor
ANOVA	analysis of variance
Ca(OH) ₂	hydrated lime, slaked lime
DM	dry matter
DTNB	5,5'-dithiobis(2-nitrobenzoic acid)
H ₂ S	hydrogen sulphide
HCl	hydrochloric acid
ICP-OES	inductively coupled plasma optical emission spectroscopy
IFOAM	International Federation of Organic Agriculture Movements
LS1	treatment containing hydrated lime and 1% lime sulphur
LS2	treatment containing hydrated lime and 2% lime sulphur
MES	2-(N-morpholino)ethanesulfonic acid
n	sample size
NaHCO ₃	sodium bicarbonate, baking soda
NaOH	sodium hydroxide
S.E.	standard error
SH	thiol
SPI	starch pattern index
SSC	soluble solids content
TA	titratable acidity
Tris	trihydroxymethylaminomethane