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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

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in

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"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.

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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