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**The impact of selected orchard management
practices on apple (*Malus domestica* L.) fruit quality**

by

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B. Sc., Grad. Dip. Sc. University of Tasmania

**Submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy**

University of Tasmania

Hobart

August 2005

Declaration

This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief no material previously published or written by another person except where due acknowledgment is made in the text of the thesis.



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Abbreviations

Abbreviations and symbols are defined when first used in the text. This list summarises those most commonly used.

a.i.	active ingredient
ATS	ammonium thiosulphate
BA	benzyladenine
dAFB	days after full bloom
DNOC	dinitro ortho cresol
FB	full bloom
GA	gibberellin
KTS	potassium thiosulphate
L/D	length/diameter
LCSA	limb cross-sectional area
LSD	least significant difference
NAA	naphthalene acetic acid
NAD	naphthalene acetamide
ns	not significant (at $P = 0.05$)
P	probability
sem	standard error of mean
TCSA	trunk cross-sectional area
TSS	total soluble solids
wAFB	weeks after full bloom

Glossary

adjuvant:	a substance added to a chemical spray that enhances penetration and action of applied chemicals
biennial bearing:	production of a heavy crop one year (<i>on-year</i>) followed by a light or no crop the next year (<i>off-year</i>)
blossom desiccant:	a caustic substance applied during the flowering period to prevent fertilisation. Acts by burning or desiccating the female reproductive parts of the flower
December drop:	in apples, the final post-bloom shedding of fruits, normally occurring in December in the southern hemisphere (June in northern hemisphere)
Flowering:	as used here, the flowering period extends from the time of emergence of the first flower on the tree until the completion of anthesis of the latest opening flowers
fruit set:	the persistence and development of an ovary or adjacent tissue following anthesis and pollination
full bloom:	in apples this is defined as that stage at which the majority of the flowers are open, and petals are just starting to fall (i.e. petals are visible on the ground or will drop if a branch is shaken lightly)
growth regulator:	term used for any hormone-like compound, whether natural or artificial
king flower/fruit:	in apples, the central flower/fruit in the blossom cluster
pack-out:	proportion of the crop that can be marketed as first quality
russet:	brownish, roughened areas on the skin of fruit resulting from abnormal production of cork tissue which may be caused by disease, insects, other injury or by a natural varietal character
spur:	short branch on which flowers and fruits are borne
strip picking:	all fruit harvested at the same time, regardless of maturity level or colour
thinning:	removal of flowers and/or fruitlets during the flowering and post-bloom period
typiness:	characteristic fruit shape, particularly development and prominence of the calyx lobes in 'Delicious'

Abstract

Orchard profitability and sustainability are largely dependent on the proportion of crop that can be marketed as first quality (pack-out). While pack-out is directly related to average fruit quality, the visual components of quality, i.e. colour, size and skin finish, predominantly determine whether a premium price is achieved. Fruit quality is the result of a complex interaction of management and environmental factors. By understanding the impact of environment, culture, harvesting, handling and storage on fruit quality, growers should be able to improve both average quality in their crop as well as improving the proportion of fruit in the highest quality grade.

Whilst management practices such as pruning, shading, and crop regulation methods have been widely studied as individual or isolated issues, the role of each in commercial orchard systems is less well understood. From the literature, it was concluded that available information was conflicting in relation to the impact of practices such as pruning and chemical thinning on fruit quality, while the impact of crop load on fruit quality was often confounded by the effect of chemicals used to manage crop load.

The impact of time and level of pruning, protection of fruit from direct sunlight, and crop regulation was studied in a series of field experiments in orchards managed to local commercial standards. An examination of level and time of fruit thinning on a range of cultivars is included along with an assessment of two new generation blossom thinners (desiccants). As these desiccants frequently cause varying degrees of foliar damage, the impact of various levels of simulated foliar damage on both crop load and fruit quality was assessed. The blossom desiccant ammonium thiosulphate (ATS) showed positive effects on fruit quality with an increase in both fruit firmness and sugar content. Potassium thiosulphate showed similar promise to ATS in terms of both fruit quality and as a method of managing crop load. Low levels of foliar damage during the flowering period had little effect on fruit quality but, where 75% or more of the leaf surface was lost, fruit quality was affected and

fruit set was reduced. This study confirmed that loss of leaf area affects fruit quality but it also showed differences between the two cultivars studied.

It has been demonstrated by this study that both the degree and timing of pruning can affect crop load, fruit size, and fruit quality. Pruning during the dormant winter period resulted in better fruit quality than when pruning was delayed until after fruit set. Summer pruning adversely affected fruit size, sugar content and fruit skin finish.

Both crop load and fruit size were reduced by overall shading of trees during early fruit development. Covering individual fruit with commercial paper ‘apple bags’ improved fruit skin finish with the effectiveness related to time of application. The earlier in the season fruit is covered, the more likely that fruit skin damage will be prevented.

Early thinning had a positive effect on fruit quality, resulting in larger, firmer fruit with higher sugar levels. Evidence also showed that early thinning caused fruit to mature earlier than later thinning. In addition, positive relationships were demonstrated between fruit sugar content and weight, between fruit firmness and weight, and between fruit sugar content and fruit firmness. These relationships have not been reported previously and demonstrate that early thinning is a valuable tool in improving fruit quality.

Overall results were consistent with the established view that major aspects of fruit quality are determined in the first few weeks of development when cell division is dependent on carbohydrates derived from storage or limited current photosynthate. This study has demonstrated that by increasing awareness of the impact of orchard management practices on fruit quality and making appropriate adjustments, the base level of fruit pack-out can be increased with minimal or no additional cost to growers.

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Past experience, if not forgotten, is a guide to the future

Chinese Proverb

Publications

1. Papers published

Bound, S A and Wilson, S J (2004) Response of two apple cultivars to potassium thiosulphate as a blossom thinner. *Acta Horticulturae*, **653**, 73-79. (Chapter 7)

Bound, S A and Summers, C R (2001) The effect of pruning level and timing on fruit quality in red 'Fuji' apple. *Acta Horticulturae*, **557**, 295-302. (Chapter 4)

2. Papers submitted

Bound, S A and Wilson, S J (2005) Evaluating the effect of ammonium thiosulphate and 6-benzyladenine on crop load and fruit quality of 'Delicious' apple. Submitted to *Australian Journal of Experimental Agriculture*. (Chapter 7)

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