Structure, function and quality development in apples

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Dedication

This thesis is dedicated to my family in recognition of the suffering they endured and the love they invested in me.

Abstract

Relationships between structure and function in apples were assessed in a series of experimental studies on different aspects of fruit quality development. A holistic model is presented that describes the major contributing elements. Special attention is directed to the mechanisms underlying the various physiological responses.

The study of the relationship between seed set, fruit shape and fruit minerals showed that fruit growth was modular and was strongly influenced by seed distribution and seed growth. This pattern influences the spatial distribution of minerals (e.g. calcium) within the fruit and thus is likely to impact on fruit storage quality. The nature of the developmental stimulus was investigated by *in situ* applications of the auxin-transport inhibitor, N-(1-Naphthyl)phthalamic acid (NPA). NPA application reduced vessel differentiation in the stalk, enhanced fruit abscission, and led to a reduced seed and flesh growth. Because of the specificity of the action of NPA, the identity of the developmental stimulus is most likely to be auxin.

The slowing and eventual stoppage of calcium import by apples is probably due to a decline in the functionality of its xylem. This decline in functionality was shown to be due to a physical disruption of the vascular bundles caused by flesh expansion. The extent of xylem dysfunction was governed by the structure and character of the tissue surrounding a particular bundle type. Flesh expansion also influences the textural properties of the fruit. The spatial distribution of intercellular air within the fruit and the shape and mutual disposition of the flesh cells were assessed using novel techniques. The radial pattern of intercellular air was not uniform indicating features that are likely to impact upon gas transfer within the fruit and thus on storage behaviour.

The mechanistic understandings gained in this thesis permit the elucidation of complex interrelations between the processes of fruit quality development. The work offers new insights into the origins of some physiological defects and indicates new lines for future research.

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