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**FRUIT QUALITY AND PRODUCTIVITY ON
APPLE REPLACEMENT BRANCHES**

**A thesis presented in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy
in
Horticultural Science
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New Zealand**

Richard K Volz

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ABSTRACT

Three different bud types were identified on vigorous horizontal to upright (replacement) branches growing on the outer tree canopy of several apple (*Malus domestica* Borkh.) cultivars ('Granny Smith', 'Royal Gala' and 'Braeburn'). These bud types were termed two-year spur, one-year lateral and one-year terminal buds. Fruit quality and productivity characteristics of these bud types, and those of old spur buds (> three years) located inside the canopy, were investigated and compared.

Final fruit set on the replacement branch was consistently greater for buds on two-year old wood than for those on one-year wood. However, there was little difference in budbreak or flowering characteristics between wood ages. When three different bud types were compared, fruit set was greatest on two-year spur buds, intermediate on one-year terminal buds and lowest on one-year lateral buds. A similar pattern in the timing of flower bud opening during bloom was also measured for the different bud types. In contrast, flower number per bud, primary leaf area at bloom and bourse leaf area after bloom were greatest on one-year terminal, lowest on one-year lateral and intermediate on two-year spur buds.

Fruit from two-year spur buds were larger at harvest than those borne on one-year lateral buds. Differences in average size ranged from 12 to 36%, depending upon cultivar and year. Fruit on one-year terminal buds were intermediate in size ('Granny Smith' only). There was no difference in seed

number per fruit between fruit of various bud types. Fruit on old spurs were also consistently smaller than fruit on two-year spur buds.

Cumulative fruit growth followed a sigmoidal curve for fruit from two-year spur buds and one-year lateral buds (fruit from one-year terminals were not considered). Absolute growth rate was greater for fruit from two-year spurs compared with fruit from one-year laterals, although relative growth rates were similar. Flower receptacle size at bloom was consistently larger on two-year spurs than on one-year lateral buds. These differences in receptacle size probably accounted for differences in fruit size at harvest.

Fruit from two-year spur buds had higher internal ethylene concentrations and starch index score at commercial harvest and were softer and had yellower flesh ('Royal Gala' and 'Braeburn') or skin colour ('Granny Smith') than fruit from one-year lateral buds. There was little influence of bud type on fruit soluble solids concentration, amount of red blush coverage on the fruit or intensity of red blush ('Royal Gala' and 'Braeburn').

Fruit on old spurs inside the canopy had lower internal ethylene concentrations than fruit from two-year spurs or one-year lateral buds for all cultivars at commercial harvest. Fruit from old spurs also had lower soluble solids concentration, poorer red skin colour development and intensity ('Royal Gala' and 'Braeburn'), greener flesh colour ('Royal Gala' and 'Braeburn') and greener skin colour ('Granny Smith') than fruit on the replacement branch.

Fruit mineral concentrations from different bud types of 'Braeburn' and 'Granny Smith' were also compared at commercial harvest. One-year terminal

buds on 'Granny Smith' produced fruit which had higher calcium, potassium and magnesium concentrations than fruit on two-year spurs, one-year lateral and old spur buds. When fruit of the same size was compared, fruit calcium concentrations, Ca:K and Ca:Mg ratios were generally highest for one-year terminal buds, lowest for one-year lateral buds and intermediate for the other bud types. For 'Braeburn', fruit on the replacement branch had similar mineral concentrations, but had lower calcium concentrations than fruit from old spurs inside the canopy.

One-year lateral buds had the lowest fruit calcium, magnesium and potassium contents for 'Granny Smith' and 'Braeburn'. One-year terminal buds produced fruit with the highest fruit mineral content for 'Granny Smith' whilst for 'Braeburn' two-year spurs had the highest mineral content. Differences in 'Granny Smith' fruit calcium content between bud types on the replacement branch were associated with similar differences in bourse leaf area.

Manual reduction in leaf area at bloom on two-year spurs reduced fruit calcium content on 'Gala' and 'Royal Gala' throughout the season. Partial removal of primary leaves reduced calcium accumulation earlier than total bourse shoot removal. On a per leaf basis, removal of primary leaves was more effective in reducing calcium uptake than removal of the bourse shoots. However, neither fruit growth, magnesium nor potassium accumulation during the season were generally affected by such treatments.

These results are discussed in terms of (1) physiological limitations to productivity and fruit quality on apple replacement branches and trees; (2)

refining current management techniques so that yield and fruit quality are maximised on such branches and trees.

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