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Defining the Hass Small Fruit Syndrome

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ABSTRACT

The Hass small fruit syndrome is ill-defined, poorly understood and the physiological mechanism of expression of this phenotype remains to be elucidated. In addressing these unresolved issues, we present a definition of the small-fruit phenotype, based on the assessment of seed coat health in a population of Hass fruit at harvestable maturity, and illustrate the relationship between the final fruit size and time of seed coat senescence.

INTRODUCTION

Although the Hass small fruit syndrome, or 'problem' as it is known colloquially, is well recognised, it remains ill-conceived. In this paper we attempt to define the small-fruit syndrome and in so doing, eliminate any present or future misconceptions regarding this phenomenon.

SEED COAT SENESCENCE AND FRUIT SIZE

Hass avocado produces two distinct populations of fruit and according to Zilkah and Klein (1987), the distinguishing feature is size. Based on a study of growth kinetics, and the determination of shape and size, these authors concluded that small and large fruit arose due to the earlier fruit set of large fruit. However, casual observation has revealed that the small-fruit phenotype is always associated with early senescence and/or death of the seed coat. In figure 1, we illustrate the relationship between size and the extent of seed coat degeneration in a population of fruit at harvestable maturity. The high percentage of seed coat degeneration in fruit of 50 90g fresh weight, and a decline in this value over the range to 210 230g fresh weight indicates that the 'grand' period of growth is arrested earlier in phenotypically small fruit, and progressively later in fruit of increasing size (mass). Thus, seed coat senescence and/or death, and the cessation of rapid growth can occur at any stage during Hass avocado fruit ontogeny. Furthermore, it is important to appreciate that all fruit, irrespective of final fruit size, will eventually develop degenerate seed coats. In fact, the latter can be considered as one of the indicators of horticultural fruit maturity, in that further growth is minimal, and the mesocarp is anatomically isolated from the seed.

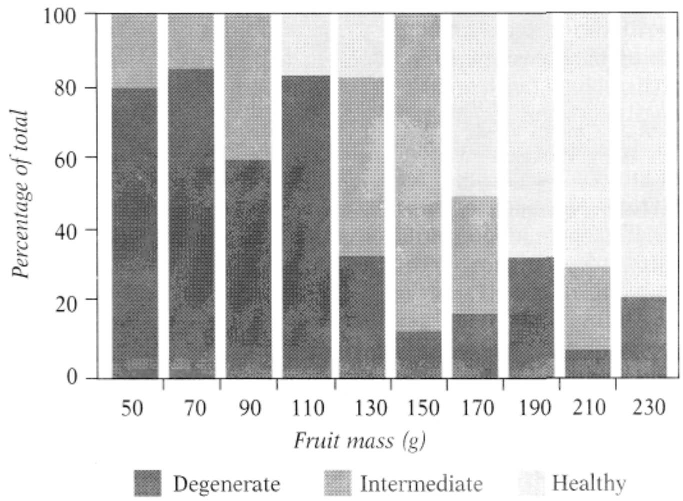

Figure 1
The relationships between seed coat viability and fruit size in Hass avocado. Similarily aged fruit of harvestable maturity from seven and eight year-old trees were sectioned longitudinally and the seed coats examined after removal of the seed. 'Healthy' seed coats were turgid and white/pale yellow in colour, 'degenerate' seed coats appeared senescent, desiccated and brown in colour. Seed coats of 'intermediate' appearance were neither 'healthy' nor 'degenerate' but showed signs of dehydration and onset of senescence

Growth of avocado fruit follows a single sigmoid curve that comprises three distinct stages:

- a slow lag phase (stage 1),
- a linear phase of rapid growth (stage 2), and
- a mature phase of slow growth (stage 3).

Fruit size and mass increase during stage 1 largely as a result of cell division whereas in stage 2, growth is characterised by reduced cell division and a major period of cell expansion. In stage 3, growth slows due to minimal cell division activity and reduced cell expansion (Schroeder, 1958; Valmayor, 1967; Zilkah & Klein, 1987). We have recently demonstrated the existence of a physiological window (time period in development), 55 60 days after fruit set, when Hass first becomes susceptible and expresses the small-fruit phenotype (Moore-Gordon *et al.,* unpublished). Associated with this window are several important phenological events including;

- cessation of the first root flush, and
- the beginning of the second (i.e. summer) shoot flush.

These occur coincident with maximum orchard temperature, humidity and irradiance suggesting that both internal and external events contribute to the expression of phenotypically small fruit. Appearance of small fruit during this critical period, assuming the fruit is retained on the tree, will yield count size 26 and greater at the time of harvest (figure 2). Since the emergence of small fruit is less frequent as growth and development proceeds, it is clear that the time of seed coat senescence determines final fruit size. Thus, the earlier seed coat senescence occurs, the smaller the fruit is likely to be (figure 2).

CONCLUSION

It is tempting to view expression of the small-fruit phenotype as a response to abiotic/biotic stress, which differentially (for unknown reasons) affects the fruit population, i.e. some fruit more than others. The precise stimuli however, remains to be determined. Recent studies in the laboratory have revealed a complex of interrelated factors involved in the metabolic control of avocado fruit growth. These include the activity of 3-hydroxy3-methylglutaryl coenzyme A reductase (HMGR), endogenous cytokinin and abscisic acid concentration, protein (de)phosphorylation, and the composition and content of source-derived carbohydrate (Cowan *et al,* 1997). Since all of these processes are influenced by stress, any one may constitute the trigger causing expression of phenotypically small fruit. It remains to be determined whether or not an environmental stress factor (or factors) is correlated with a particular phenological stage, as a 'critical period', thereby effecting the ability of a percentage of fruit on the tree to maintain viable seed coats.

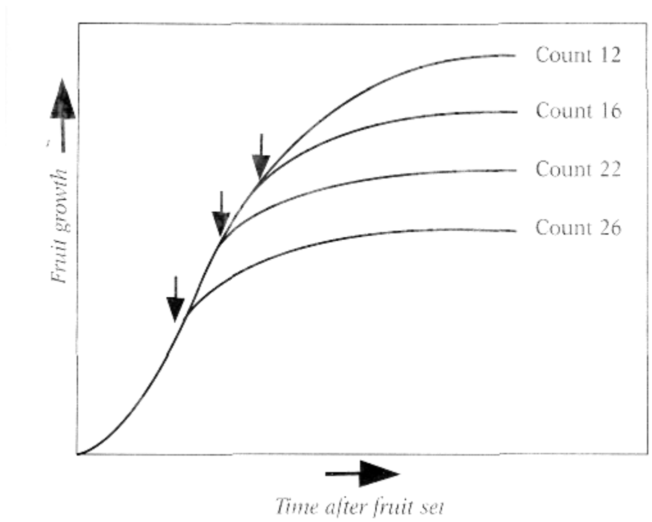

Figure 2
Proposed relationship between the final Hass avocado fruit size and time of onset of seed coat senescence as a function of growth. Arrows indicate the time, during growth, at which seed coat senescence is induced

Acknowledgements

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