PLANT HORMONE HOMEOSTASIS AND THE CONTROL OF 'HASS' AVOCADO FRUIT SIZE

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ABSTRACT

The 'Hass' avocado produces two distinct phenotypically different populations of fruit, i.e. normal and small fruit. The small fruit variant is characterized by early seed coat senescence that results in arrested growth, due to dramatically reduced cell cycle activity. This system has been used to study the metabolic control of fruit growth for two reasons. Firstly, the 'Hass' avocado is a major export crop in South Africa and unmarketable small fruit cost the industry millions of rands per season. Secondly, in the absence of evergreen tree-crop mutants with which to dissect controlling mechanisms contributing to the control of final fruit size, the 'Hass' avocado and its small fruit variant provides an ideal system to investigate the physiology, biochemistry and molecular biology of fruit growth in subtropical species. A detailed study was conducted to probe the contribution of hormones in the control of final fruit size by comparing and contrasting tissue distribution and content of hormones in developing 'Hass' avocado and its small fruit variant. In addition the proposal that changes in hormone homeostasis occur as a result of differences in the allocation of the molybdenum cofactor (MoCo) and changes in the activity of xanthine dehydrogenase (XDH) and the aldehyde oxidases (AO) involved in abscisic acid (ABA) and indole-3-acetic acid (IAA) metabolism was evaluated.

Activity of XDH, xanthoxal (XAN) oxidase, indole acetaldehyde (IA-ald) oxidase and cytokinin oxidase (CKOX) was related to tissue content and composition of IAA and ABA. Comparisons between normal and small fruit revealed that under conditions where CKOX is elevated, the increased adenine produced inhibits XDH activity, which leads to elevated activity of the AOs involved in ABA and possibly IAA biosynthesis as a result of increased MoCo allocation to these enzymes. Further analyses revealed that both cytokinin (CK) and auxin elevates CKOX activity and that adenine and CK do indeed inhibit XDH activity, which leads to increased AO activity. In addition, application of CK to normal fruit increased IAA in mesocarp tissue but reduced IAA content of seed tissue and reduced ABA in mesocarp tissue but had no effect on ABA in seed tissue. Cytokinin oxidase therefore contributes to the regulation of ABA and IAA metabolism during plant organ growth by modulating the activity of XDH.

Low XDH and IA-ald oxidase activity together with high XAN oxidase and CKOX activity early in fruit development combine to reduce both elongation and radial growth, which

results in the appearance of the 'Hass' small fruit phenotype. This event was associated with high ABA and low IAA in seed tissue of small fruit, but high ABA and IAA in seed coat and mesocarp tissue of these fruit. Thus, whilst low IAA in seed tissue is associated with reduced growth the reverse is true in seed coat and mesocarp tissue where high IAA retards tissue growth. Calculation of CK/ABA and CK/IAA ratios revealed that a decrease in these ratios was found in mesocarp tissue of small fruit. However, in seed tissue of small fruit both IAA and ABA were decreased relative to CK. The maintenance of the correct hormonal balance in avocado fruit thus ensures the continuation of cell division cycle activity, with any changes responsible for the high incidence of a small fruit variant in the 'Hass' avocado.