ABSTRACT

Tree fruit crops generally consist of scion and rootstock components, which through interactive synergism affect tree performance. Coupled with tree architecture, sink/source relationships (both spatial and temporal), genotypic responses to environments, and carry-over seasonal effects present a high level of complexity which often confounds research results. The development, description and use of pheno/physiological models as research and crop management tools is a new holistic approach to reduce complexity and improve understanding of the critical factors which influence crop productivity.

A pheno/physiological model is described for cv. Hass avocado growing in a cool, mesic subtropical environment in S.E. Queensland, Australia. Seasonal shoot and root growth had bimodal periodicity with root growth offset and delayed with respect to shoot growth. The priority sink strength of developing shoots compared with roots was confirmed with ^{14}C studies. Root growth in summer extended through until late winter when there was a substantial decline following anthesis - a critical time in fruit development with competition between reproductive and vegetative sinks for limited resources. Delayed harvesting of fruit over several seasons resulted in alternate bearing patterns, while removal of fruit at the minimum legal maturity of 21 to 24% dry matter sustained successive high yields. With cv. Hass, production was directly related to starch concentrations in trunks or shoots in July (mid-winter) immediately prior to anthesis. However, seasonal starch concentration fluxes in trunks were much lower in coastal subtropical Australia compared with those previously reported from interior areas in more southerly latitudes (7.5% vs. 18% maximum). Current assimilate from over-wintered leaves was necessary to bridge the gap in early spring between the depletion of starch reserves by new reproductive and vegetative shoot growth, and the sink/source transition of the spring shoot growth.

Net CO_2 assimilation of summer grown leaves reached ca. 17 μmol CO_2 m^{-2} s^{-1}, approximately twice as high as previously reported rates on container-grown plants or trees in restrictive soils. Photosynthesis was depressed by photoinhibition during winter when mean minimum temperatures were < $10^{o}C$ for 50 days, this being the first report of this phenomenon in field-grown avocado trees. Partial recovery occurred prior to senescence of previous season's leaves in spring after minimum temperatures increased above $10^{o}C$. The plasticity of the light response was high with the compensation point for net CO_2 assimilation at 30 μmol quanta m^{-2} s^{-1} and the light saturation point at 1270 μmol quanta m^{-2} s^{-1}. Net CO_2 fixation from fruit photosynthesis was always less than losses through respiration but was highest during the first few weeks of ontogeny, perhaps contributing to the fruit's own carbon economy at a time when competition for assimilates was greatest. In general, CO_2 assimilation studies with current technology applied to orchard trees in non-restrictive soils have elucidated efficiencies more akin to deciduous than evergreen trees - thereby compensating for short-lived leaves and energy expensive fruits.

Pheno/physiology models were used to substantiate the most effective timing for trunk injection of ambimobile phosphonate fungicides for the control of Phytophthora root rot, a serious disease of avocados, viz. at the completion of the leaf expansion phases when leaves were strong net exporters. Preliminary studies demonstrated potential yield increases when the assimilation efficiency of photoinhibited over-wintered leaves was improved through increased nitrogen concentration, and spring shoot growth was partially suppressed with foliar sprays of the growth retardant paclobutrazol.

DECLARATION

I hereby declare that the research reported in this thesis is the result of my own investigations, except where acknowledged, and has not, in its entirety or in part, been previously submitted to any University for degree purposes.

Signed ________________________

(A W Whiley)