INTRODUCTION

The avocado is a fruit of subtropical and tropical central America and Mexico though its precise origin is obscure due to its long history of cultivation. The name for this fruit is derived from the corruption of the Spanish *ahuacate* or *aguacate*, which in turn are adaptations of the Aztec *ahuacatl* (Popenoe 1920). Its centre of diversification is thought to encompass the subtropical and highland tropical areas of Mexico, Guatemala and Honduras (Kopp 1966) where it grows as a rainforest species. When the Spanish arrived in central America the avocado was cultivated from Mexico to Peru (Hodgson 1950) where its high food value was recognised by the indigenous people. Activities associated with the European colonisation of this region soon carried the avocado to Venezuela (Serpa 1968), the West Indies (Hume 1951), Chile (Schmidt 1965), the Madeira and Canary Islands (Cabezon 1965) and other areas of the Spanish Empire suiting its cultivation. Today it is grown in many areas of the world encompassing diverse environments ranging from semi-arid/Mediterranean to humid/tropical thus demonstrating the adaptability of this fruit crop. Total world production of avocado in 1991 was estimated at 2,036,000 tonnes (Anon. 1991).

Avocado (*Persea americana* Mill.) (syn. *Persea gratissima* Gaertn. f., 1807; *Persea drymifolia* Schlecht. & Cham. 1831; *Persea nubigena* Williams 1950), belongs to the aromatic laurel family (Lauraceae) of which only one other genus, *Cinnamomum*, is appreciably cultivated yielding cinnamon and camphor (Bergh 1975). All *Persea* species studied have a chromosome number of 2n = 24 (Bergh 1975). Three ecological races are identified within *P. americana* and are given varietal status within the species (Bergh *et al*. 1973; Bergh and Ellstrand 1986; Scora and Bergh 1990); viz. *P. americana* var. *drymifolia* (Mexican race), *P. americana* var. *guatemalensis* (Guatemalan race) and *P. americana* var. *americana* (West Indian or Lowland race). Trees of the West Indian race are the most tolerant to alkaline and saline soil conditions while those of Mexican race origin are the most tolerant of low temperatures. The races hybridise freely, giving rise to genotypes with adaptation from cool semi-arid to hot humid ‘tropical lowland’ climates. Fruit of Mexican and Guatemalan races have more oil in their mesocarp at maturity (10 to 30%) than fruit of the West Indian race (3 to 10%). Fruit of the Mexican race have the thinnest skins

while fruit belonging to the Guatemalan race generally are the latest maturing of the three races. Production in the lowland tropics is centred around West Indian and West Indian x Guatemalan cultivars. Guatemalan and Mexican race cultivars and their hybrids dominate the technologically more advanced industries of the subtropics.

Commercial avocado production in Australia occurs in all mainland States which cover a diversity of environments, ranging from the semi-arid/Mediterranean in Western Australia to warm subtropical with predominantly summer rainfall in Queensland and northern New South Wales. Approximately 80% of production is from the subtropical areas of the country. By world standards the Australian avocado industry is small producing 20 000 tonnes in 1993, of which 95% was consumed on domestic markets. Currently the industry is in a rapid growth phase repeating the expansion cycles of the mid 1970's and the early 1980's. Interest is being shown in the development of new markets for both fresh and processed fruit. Export is a consideration, however due to geographical isolation and higher labour costs compared with other major producing countries, the Australian industry will require a technological edge to compete effectively in international markets. In particular, the assurance of well-above average yields of quality fruit will be necessary.

Major constraints identified by industry in relation to export include low yields, unreliable fruit quality and high production costs, the latter being due to expenses associated with managing large trees. Low yield with respect to other fruit crops has to some extent been explained by Wolstenholme (1986, 1987), however there remains a large gap between the $\approx$ 32 t ha^{-1} target potential (Wolstenholme 1986) and the industry average for bearing trees of ca. 12 t ha^{-1} (Whiley and Winston 1987). In some situations production of > 20 t ha^{-1} has been sustained for a number of years, but inevitably tree size becomes excessive and management strategies which result in major yield loss for a number of years are necessary, e.g. staghorning, heavy mechanical pruning.

Research reported in this thesis deals with Mexican and Guatemalan race cultivars or their hybrids growing in humid, moderate to high rainfall subtropical climates in S.E. Queensland. The author has used an holistic approach in studying the growth and development of avocado which has been documented in pheno/physiological models. Earlier reports on some aspects of avocado physiology covered in this thesis were confined to container-grown trees (Bower *et al*. 1978;

Scholefield *et al*. 1980), or field-grown trees in soil conditions in Florida, USA which mimicked container-grown responses (Schaffer *et al.* 1987). However, recent changes in technology have allowed detailed measurements reported in this thesis to be made on field-grown trees. The prime objective of the research was therefore to apply modern technology to a range of potentially yield-limiting factors, identified from the construction of a pheno-physiological seasonal growth model, with a view to a more sophisticated understanding of how to manipulate the tree during critical periods. The approach has been holistic, at the whole-tree level, with a strong eco-physiological bias, and ultimately directed at solving grower problems in the orchard situation. The result is substantially changed views on some aspects of physiological limitations on the yield performance of avocado trees. Improved understanding of tree phenology and physiology has assisted in the development of more sophisticated management strategies which potentially will reduce production costs and improve avocado yield and quality.