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NUTRIENT BALANCE AND NUTRIENT AVAILABILITY AS MANAGEMENT TOOLS TO ACHIEVE LARGE FRUIT SIZE AND HEAVY CROPPING IN MATURE 'HASS' ORCHARDS

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The primary purpose of nutrition is to provide the avocado (*Persea americana* Mill.) tree with sufficient minerals to ensure tree growth, tree health and cropping. Nutrition can also be used to drive certain phenology events, such as the determination of flush type, manage flush balance and ensure the correct fruit to leaf ratios. The purpose is to ensure regularity of cropping and to provide customers and consumers with fruit of a specified quality.

Primary approaches to nutrition are:

- Deficiency identification and amelioration based on straight fertilizer application. In most cases this is the primary approach used in trace element nutrition, for example boron.
- Nutrient replenishment based on a calculated orchard loss formula. In this approach the mineral loss through fruit removal or leaching, and utilization by tree growth is determined and an appropriate amount of fertilizer applied which compensates for the loss.
- "Need" based on a range of norms. This approach is widely used and relies on the "setting" of nutrient leaf and soil norms and then correcting the nutrient amount when it moves from the "set" nutrient norm. The approach is reactive and retrospectively corrective.
- DRIS (diagnosis and recommendation integrated system) based nutritional approach is an old but useful additional approach and its use as part of a nutritional package for avocado is reported on.

The experimental approach is understanding that a range of factors from totally uncontrollable (for example light and temperature) to controllable (for example cultivar and orchard practices) affect plant response which in turn affects yield and fruit quality. It is important that each of the important factors which influences fruiting and fruit quality is identified and allowed for in the conceptual model. Each orchard block for which there is discrete information represents one given sample. The information collected includes yield, fruit size distribution, flowering intensity, flush balance, soil type, soil analyses, leaf analyses and certain block data such as spacing and trees age for example. The blocks, which are the actual components of the system, are considered analogous to the replications of a traditional experiment, unlimited in their number (sufficiently large) and located at random (anywhere). In the modified DRIS approach described here each commercial block for which data is available becomes a replication in a massive nutritional experiment.

With years and nutritional refinement a set of DRIS nutritional targets and ratios emerge. The primary difference compared to other more passive nutritional approaches is that nutrition is used to actively "drive" certain physiological growth patterns. Good fertilizer science is incorporated and there has been an attempt to design better nutritional products. For example:

- To use products with a low salt index to minimize root damage when fertilizer is applied.

- To combine nitrogen and phosphate in the same granule to increase phosphate uptake.
- To maintain a balance of cation ratio between potassium, magnesium and calcium both in total supply and availability (solubility).
- To reduce chloride contamination to a minimum.
- To have phosphate in both readily and slowly available forms to reduce soil fixation.
- To reduce leaching losses and ion antagonism using sulphate forms.
- To reduce acidification.
- To have calcium supply which should enhance potassium uptake.
- To have two forms of nitrogen.
- A product compatible with accurate low volume spreading equipment.

It is important to develop the concepts of both level and ratio in both plant and soil for important elements. The elemental ratios in nutrient deficient trees can be similar to well fertilized trees if only ratios are considered. There is therefore an absolute requirement for leaf target levels. Important targets and ratios are specific leaf levels (rather than ranges), leaf ratios, soil target levels (rather than ranges) and soil ratios. These targets and ratios have been established for ‘Hass’ on two New Zealand soil types, a sandy soil comprising largely wind blown dune sands with a thin organic top horizon (Far North of New Zealand) and a light, highly leached, free draining, volcanic soil (Bay of Plenty and Whangarei).

Important considerations used are:

- Calculating the nutritional requirement. Here an iterative approach has been used where the annual nutrient supplied has been calculated and then analyzed against yield, tree response and the leaf and soil results down stream.
- Optimizing soil properties. Concepts such as soil compaction, soil aeration and soil pH are important to ensure a healthy root system and to ensure that roots are capable of foraging correctly. Season plays an important part in New Zealand with regard to soil condition particularly in winter when typically up to 1200 mm of rainfall can fall over a 4 - 5 month period and effectively water log even well drained soils.
- Understanding the effect of treatment on soil properties. Here the understanding of soil and fertilizer chemistry is important. Nutrient balance and supply (particularly release), organic mineralization, soil water solution, soil water availability and soil aeration are just a few of the considerations that are catered for in the DRIS program.
- Understanding plant response to fertilizer (rate and timing) is important to prevent over fertilizing and to ensure that the required physiological response is obtained. A primary aim is to obtain a 50 - 60% determinate flowering to ensure cropping, enough canopy for fruit sizing and to provide fruiting wood for the following season.
- Understanding fertilizer science (soil interactions) and being able to overlay orchard practices on the nutritional program.

Some specific leaf and soil targets and ratios have been developed. It must be noted that these were developed on and are for New Zealand environmental conditions and soils. The ratios and levels are largely associated with vegetative vigor balance and adequate potassium supply. At this stage there is no clear picture regarding ratios between macro-elements and micro-elements.

Some particularly interesting trace element trends have emerged from the database. Of interest is that high yields of well shaped, large fruit can be obtained with leaf boron levels of 25 - 30 ppm but only when other nutrients have been well supplied. Several orchards for example under conditions of high nitrogen, potassium, magnesium and calcium supply show no classical symptoms of boron deficiency even at leaf analysis levels of 25 - 28 ppm. Yields are high (in excess of 25 tons per ha) and sustainable (in excess of 20 tons per year over 4 years). Zinc nutrition is a concern under New Zealand conditions. The leaf zinc trend in nearly all blocks in this DRIS program has been downwards over the past 5 years. Supplemental application has not reversed the trend and this element may be experiencing soil retention difficulty under conditions of high competing cation supply, particularly when base saturation exceeds 85%. This element is receiving aggressive attention at present.

Currently there are over 400 blocks being used to define and refine the DRIS norms for 'Hass' avocado. Some blocks have been in the program for over 5 years and others are only in their first year. The combined data from this approach has been used to determine important ratios to secure consistent heavy production of large fruit under New Zealand conditions. The program is still under development and further years and data is required. However, we currently have good usable DRIS levels and ratios for most of the macro elements. Our understanding of fertilizer science in relation to avocado has improved and there are new and superior products available in New Zealand now which were not available five years ago. Further determination of specific nutrient levels and ratios as well as the calculation of nutrient requirement is on going. The intention is to have the program finalized by 2005.