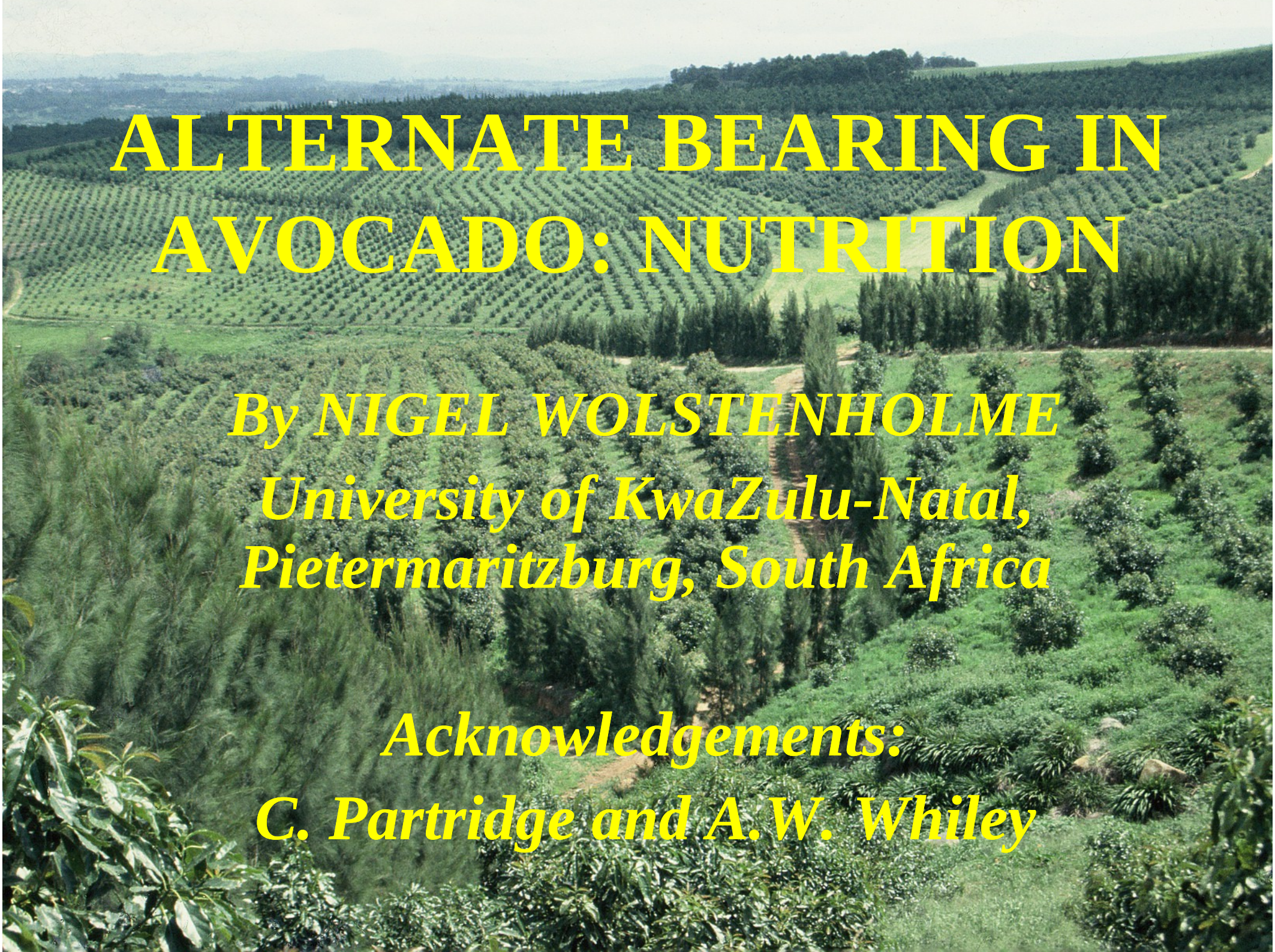


ALTERNATE BEARING IN AVOCADO: NUTRITION

By NIGEL WOLSTENHOLME
University of KwaZulu-Natal, Pietermaritzburg, South Africa

Acknowledgements:
C. Partridge and A.W. Whiley

ALTERNATE BEARING (A.B.) IN AVOCADO IS ULTIMATELY CAUSED BY EXCESSIVELY HEAVY ‘ON’ CROP CAUSING:

- Reduced fruiting sites for next crop
- Reduced flowering intensity next season
- Reduced cropping (‘off’ season)

THE HEAVY ‘ON’ CROP ADVERSELY AFFECTS:

- Spring and summer flushes (esp. summer)
- Root flushes (esp. autumn)
- Leaf and feeder root renewal / longevity
- Flower initiation for following crop
- CHO reserve build-up in autumn / winter during the ‘on’ season

Many, complex, interacting factors affect the onset and severity of A.B.

All are potentially limiting.

One of the controllable factors is nutrition.

P.c. root rot reduces leaf **N**, **P**, **S**, **Zn** and **B**.

For effective nutrition, P.c. control is non-negotiable.

WHAT ARE THE UNIVERSAL PRINCIPLES OF AVOCADO NUTRITION?

- ‘Energy expensive’, but ‘mineral cheap’ fruiting
- Manipulatory and non-manipulatory elements
- Vegetative: reproductive balance maintenance
- Established soil and leaf analysis norms
- Adherence to scientific results and the scientific method
- Complexity of climates and soils

THE ENERGY EXPENSIVE / MINERAL CHEAP CONUNDRUM

- Relatively low yields in avo due to ‘energy expensive’ oil (as opposed to sugars) in fruits
- Good cropping requires many efficient leaves
- Although individual fruits are mineral-rich, fruiting is comparatively ‘mineral cheap’ on a hectare basis
- An avocado crop of 30t/ha is as energetically and technologically efficient as citrus and apple crops of 60-100t/ha
- Avo orchards are much less “heavy on the soil”

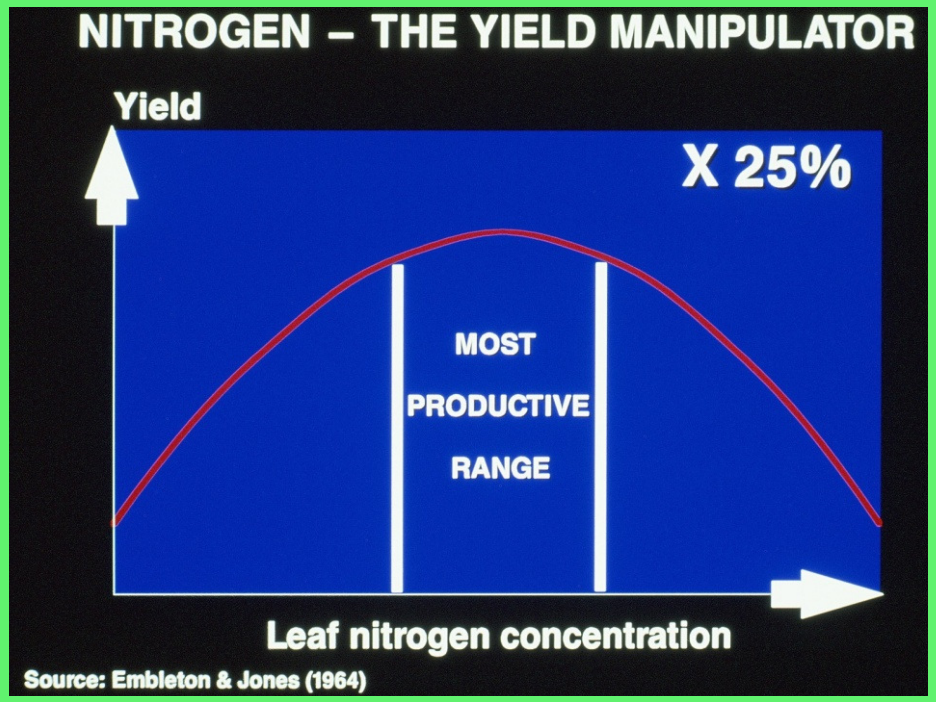
NUTRITION NEEDS ARE LOWER, BUT NOT NECESSARILY LOW, DEPENDING ON:

- Yield / crop load, e.g. 20 vs 10t/ha
- Soil type and fertility, e.g. O.M. rich clay loams vs sandy soils
- Rainfall (soil and leaf canopy leaching) and climate
- Management philosophy
- Rootstock / scion combination

MANIPULATORY AND NON-MANIPULATORY ELEMENTS

Nitrogen (**N**) – manipulatory element

- Controls vegetative / reproductive balance
- **N** fertilization: 0 – 200kg **N**/ha/an
- **N** leaf norms usually 1.8 – 2.6% (cultivar, rootstock, growing conditions, management technology)



LEAF ANALYSIS NORMS

- Remarkably similar between countries
- Some fine-tuning for cultivar, growing conditions
- Highlight importance of **N**, **Zn**, and **B** and maybe **K** in moist subtropics
- Importance of liming to ameliorate **Al** and sometimes **Mn** toxicity in acid, leached soils
- Future research on **Mo**, **Ni** and **Si**
- Amount and timing relative to phenology

SOIL ANALYSIS NORMS

- Some variability in measuring nutrient availability
- Scientifically correct method is to determine through ongoing research the soil sufficiency **amount** giving high yield and quality fruit
- The Albrecht system based on **K**:**Ca**:**Mg ratios** is rejected by modern research soil scientists and state-funded analytical laboratories

N FERTILIZATION NEEDS ARE REDUCED WHEN:

- Soils high in O.M. (mineralization releases up to 150kg **N**/ha/an ‘free’ **N**)
- High clay content (basalt or dolerite derived krasnozems and humic oxisols)
- Trees invigorated by pruning, cultivar / rootstock, low cropping (‘off’ year)

TIMING OF SOIL **N** FERTILIZER (CALIF.)

Lovatt (2001)

- 20 year old Hass on Duke 7, 168 trees / ha
- All trees received 168kg **N**/ha (irrigation)
- Equal applications at six times (28 kg **N**/ha each) between Jul and May (S.H. equiv.) is California standard
- Extra (double) dose of 28kg **N**/ha applied at five selected phenological stages
- Four year trial (2 on/off bearing cycles)

RESULTS

(Lovatt, 2001)

- Only extra **N** in Oct (S.H. equiv.) significantly reduced A.B. (from 0.90 to 0.72) (early fruit set, initiation of spring flush).
- Highest 4 year yield with extra **N** in May and April (Southern Hemisphere equivalent (S.H.))
- Extra **N** in Jul and Aug and Dec (S.H.) was not beneficial
- Yield not correlated with leaf **N** (Mar. (S.H.) sample)
- Timing of **N** application important

FINE-TUNING **N** FERTILATION

- Local conditions and research experience (not opinion and anecdote)
- Timing (e.g. Lovatt, 2001)
- ‘On’ vs ‘Off’ years
- Balancing need for sufficient shoot growth with adverse effects on fruiting and fruit quality (Excess **N** → reduced **Ca** uptake)

ORCHARD INTENSIFICATION CONSEQUENCES

Smaller trees and higher planting densities result in:

- **Greater importance of nutrient management**
- **Earlier cropping and higher yield**
- **Smaller root systems**

Leaf and soil analysis are standard tools for diagnosis of tree nutrient status,

BUT

Do not reflect actual **amount** and **timing** of tree nutrient requirements.

RESEARCH SEASONAL UPTAKE PATTERNS

- Biomass determination via sequential tree excavation
- Nutrient analysis of each tissue type
- Difficult, expensive and unpopular research
- Problem of remobilization of some nutrients from perennial, woody tissues (accumulated storage reserves)

NUTRIENT DYNAMICS STUDIES AIDED BY

- Sand culture experiments which complement field studies
- ^{15}**N-**labelled fertilizers aid **N** dynamics studies
- Avocado research needed

(Cheng and Raba, 2009 – apple study)

THE N.Z. SITUATION: NUTRIENT LIMITATION?

- Highly leached, acid, often infertile soils
- 1800 – 2000mm mainly winter rainfall
- Significant **N** and **K** leaching from leaves in winter
- Cold, often semi-saturated soils in spring
- Probable feeder root wipe-out leading up to flowering

N.Z. SITUATION (cont.)

- **N** fertilizer timing
  - Soil application pointless until soil temp. > ca. 15°C, and feeder roots replenished?
  - Wait until rainfall intensity decreases (less leaching, especially on sands)
  - Foliar sprays helpful, but not when subject to heavy rain
  - Autumn applications to boost **N** storage reserves?

ORGANIC PRODUCTION

- Price premium can be significant
- Difficult and more expensive – reversion to early 1900's technology
  - Animal manures, green manures
  - 'Organic-approved' Zn and B available
  - Restricted Cu sprays (twice p.a.)
  - Mulching vs Phytophthora
  - Complicated regulatory environment
- Reduced yield; A.B. more difficult to control

COMPOST TEA

Produced from vermicasts, vermicomposts and many different composts

Used for:

- Disease suppression
- Supplemental plant nutrients
- Enhanced soil microbial life

COMPOST TEA (cont.)

- Disease suppression highly variable
- Lack of standardization of product
- Scientific background lacking
  - Scientific, replicated research needed
  - Use based on faith or anecdotal evidence
- Not yet ‘mainstream science’

(Recycled Organics Unit, Univ. of N.S.W., 2007)

CONCLUSIONS

- Leaf and soil analysis norms guide fertilization
- Scope for research on timing and amount, as influenced by local conditions
- Key is better maintenance of veg. – reprod. balance in ‘on’ and ‘off’ years
- Only apply nutrients if scientific research shows a need; when uptake is assured; and with due regard to amount and timing
- A.B. cannot be controlled only by better nutrition