1. **Soil, Salinity and Nutrition**

2. Soils are classified according to:
   - Their origin—e.g., volcanic ash, granite deposit, organic peat
   - Mineral or Inorganic and organic soils—arid climate
   - Soil reaction—pH: acidic, neutral and alkaline
   - Water holding capacity
   - Cation Exchange Capacity (CEC)
   - Ratio of Particle Sizes

3. **Soil pH**
   - Nutrients affected by pH: Cu, Fe, P, K and Mg.
   - To increase pH
     - Calcite (Ca)
     - Dolomite (Ca and Mg)
   - If pH is normal
     - Gypsum is used when Ca is deficit
     - Soil application—MgSO₄ or MgO and Foliar application of Mg(NO₃)₂ when Mg deficit.

4. **Water holding capacity (WHC)**
   - Field Capacity (FC): In saturated soil, after free drainage (gravitational potential=0), the soil water is held principally in the soil pores as well as in a continuous film around the soil particles.
     - Metric potential is -1/3 bar
   - Permanent Wilting Point (PWP): When the metric potential decreases until it becomes equal to that of plant so that plant can no longer obtain water
     - water potential= -15 bar
   - WHC = Amount of water held betn. -1/3 to -15 bars

5. **Ratio of Particle Sizes**
   - Class | Particle diameter (mm)
   - --- | ---
   - Clay | < 0.002
   - Silt | 0.002-0.02
   - Sand | 0.02-2.0
   - Gravel | > 2.0

6. **Factors to Consider in Developing Nutrition Program**
• Soils and Production areas
  – The well drained soils:
    » Good drainage
    » good aeration
    » deep root zone: lack of hard pan
  – The Poorly drained soil
    » Higher Cation Exchange Capacity
    » Higher nutrient uptake
    » Higher water holding capacity

Site Selection and Land Preparation
  – Nutrient status, freeze potential and drainage limitations, soil pests and diseases.
  – Avoid high calcareous soil and sandy soils

Soil pH

Environmental Issues
  – Vulnerable Ridge soils: low O.M. and leaching
  – Nitrates in groundwater

Essential Nutrient Elements

Nutrient Requirements

Nutrient and Fruit Quality

Management Practices
  – Tissue analysis and soil analysis
  – Fertilizer formulations
  – Method of application
  – Fertilizer guidelines

Soil Analysis
  • Used with field observations, leaf and yield analysis
  • Monitor: Mg, Ca, Cu and P
  • Soil Sampling
    – Soil auger or shovel
    – 30 cm around dripline of the tree
    – 16 samples in 8 ha (if uniform soil)

Soil Analysis (contd.)
  • Common extractants used:
    » Mechlich-1 (double acid)
    » Neutral ammonium acetate
> Ammonium acetate (pH=4.8)
> Bray P1 and P2
> Sodium bicarbonate

- Expressed as extractable levels instead of available levels
- Interpretation of test results

11 Interpretation of test results

- Soil test may estimate very well available nutrients but not how they become available to the plants.
- Soil tests must be calibrated under field conditions.
- Field fertilization trials are the ultimate checks. The interpreter must be familiar with the local fertilizer experiments in order to make the most from the chemical analysis of soil.

12 Nitrogen Effect on Yield of Ray Ruby

13 Tissue Analysis

- Selection of management units
  - grouping like areas: variety, tree age and soil
- Leaf sample collection
  - 100 leaves (8-10 /tree) from 20 trees in a 8 ha
  - four-to-six month-old spring flush leaves from non fruiting twigs
  - age of leaf (fig 5.5)
- Sampling time: July to September
- Leaf contamination

14 Tissue Analysis (contd.)

- Leaf analysis is preferred to soil analysis
- relatively costly and complicated
- Extensive studies-leaf age, location on the shoot and fruit load on nutrient levels
- Higher in non growing than growing shoots
- N-Kjeldahl process
- Percentage of dried leaf-N, P, K, Ca, Mg, Na, Cl.
- PPM of dried leaf-Zn, Mn, Cu, Fe, B

15 Fertilizer Formulations

- Granular: Bulk blended (N, P and K Plus micronutrients)
- Solution sources: Free of solids- Urea, Amm. nitrate, KNO₃, KCl etc.
  - Suited for microsprinkler, drip irrigation (Caution-P).
• Suspension sources: fluids in which solids are held in suspension by use of suspension agent (e.g., bentonite) fertilizer-herbicide mixture
• Foliar N sources: Low biuret

16 Fertilizer Formulations (contd.)
• Slow release sources: limited water solubility
  – Ureaform
  – Organiform
• Controlled-release sources:
  – Delays the availability for plant uptake
  – Sulfur, polymers, and waxes

17 Method of Application
• Fertigation: Application of liquid fertilizer through irrigation
  – Multiple application
  – wetted areas of the rootzone
  – Electric conductivity of irrigation water >1000 ppm
  – Fertigation rate and times should be calibrated for each irrigation zone
  – Rate can be measured chemical flow meter or volumetrically

18 Injection Volume
Volume = \( \frac{Ac \times N \times F \times Wt}{1000} \)
Vol = Volume of fertilizer to be injected
Ac = the area to be fertigated (acres)
N = the amount of N applied per acre (lb N/acre)
F = the amount of N fertilizer expressed as fraction (F=0.08 for 8-0-8 analysis)
Wt = fertilizer solution weight per gallon (lb/gal)

19 Fertilizer Guidelines
• Non Bearing trees:
  – Minimize adverse effect of weed, disease, pest and freeze damage
  – Nitrogen and irrigation
  – N level of nursery trees
  – Soil type
  – Land history
  – Fertilizer source
  – Fertilizer placement
  – Frequency and timing

20 Recommended N rates and no of appln. for nonbearing citrus
trees

21  Fertilizer Guidelines (contd.)
- Bearing trees:
  - Fruit quality is important
  - Systems wetting more ground area is preferable
  - Rates should be longer
  - Crop load
  - Varieties
  - Leaf and soil analysis
  - Tree age and placement
  - Frequency and timing

22  Recommended N rates and no of appln. for bearing citrus trees (4 years and older)

23  Special situations
- Scion and Rootstock nutrition requirements
  - pounds solids per acre: orange and grapefruit require high N
- Rootstock/nutrition interaction
  - Carrizo citrange and Swingle citrumelo: high pH exhibits ZN, Mn, Fe and Mg deficiency
- Calcareous soils (pH =7.6 to 8.3)
- High Saline soils

24  High Saline Soils
- What is Salinity?
  - A white crust on the surface of the soil (white alkali): mixture of Na, Ca, and Mg.
  - Moist, dark, oily spots indicate an excess of Ca Cl₂
  - dissolve in water
- Where Do Salts Come from?
  - Irrigation water: 2000 lbs of salt/acre-foot water
  - High ground water table
  - Original deposits of salt in soils

25  High Saline Soils (Contd.)
- How does salinity affect plant growth?
  - Decreasing availability of water to plants via osmotic effect
  - Direct toxic effects: necrotic, bronzing.
- How do we measure Salinity?
  - Electric conductivity of the saturation extract
» The unit of measurement is deci-Siemens per meter (dS/m) or mmho/cm
» 1dS/m = 1 mmho/cm = 700 ppm

– Chemical analysis

26 U.S. Salinity Lab Classification

27 High Saline Soils (Contd.)

• Rootstocks-Tolerance
  – Cleopatra mandarin > sour orange > sweet orange > Swingle citrumelo > rough lemon > Carrizo citrange

• Saltiness that affect plant depends on:
  – Moisture of the soil
  – Amount of soluble salt
  » clay soil is more injurious than sandy soil

28 Relative increase in salt concn. resulting from use of moisture by plants

29 Soil Salt, Chloride and Boron Tolerances in Citrus

30 High Saline Soils (Contd.)

• How can we prevent salt build up?
  – Proper irrigation and management practices
  – Good drainage
  – Irrigate adequately

• What is a leaching requirement?
  – The percentage of applied irrigation water that must pass through the root zone.

31 Leaching requirements