Crop Management Practices
Fertigation

By
Simon Bedasie
Observations of a Visiting Consultant

– Water and fertilizer management looked like “bucket chemistry”.
– Very basic techniques for water and fertilizer management were supplied by the GH Companies.
Definition:

– Fertigation is the application of fertilizers, soil amendments or other water soluble products through an irrigation system.
Some Advantages

– Healthier plants.
– Quick delivery to plant roots.
– Nutrient requirements can be adjusted with immediate effects.
– Less labour.
– Less water utilization.
– Reduced run off.
In T&T, crops are grown on raised or framed beds with their roots in the native soil, introduced soil or a soil based mix.
Crops are also grown in bags or pots with the rooting media ranging from soil-based mixes to soilless substrates.
Greenhouse Production

When grown in bags or pots, plant roots are confined to a small volume of substrate which allows for more efficient fertigation.
During production, the substrate will undergo changes based on the type of substrate, inputs applied and exudates from the plant roots.
Closed Irrigation System

NFT is an example of a hydroponic system with closed irrigation as the nutrient solution is collected and recirculated.
Open Irrigation Systems

In an open irrigation system the nutrient solution is applied to the root zone and the excess goes to waste.
Nutrients in Solution

- Nutrients are supplied mainly as inorganic fertilizers.

- Nutrients must be in solution before they can be taken up by plant roots.

- Nutrients in solution are in an ionic form with a positive or negative charge.
Cations

– Nutrients with a positive charge are called “cations”.

– Cations loosely attach themselves to negatively charged sites on substrate particles and gradually released for root uptake.
Cations

– The amount of cations held by the substrate determines the frequency of fertilization.

– Hydrogen ions (H⁺) are released by the plant roots during the uptake of cations creating acidic conditions in the root zone.
Anionns

– Nutrients with a negative charge are called “anions”.

– Anions remain free in solution and are easily lost due to excessive watering.

– Plant roots release hydroxyl ions (OH\(^-\)) when anions are absorbed causing pH to rise.
Illustration of Cations attached to a substrate particle.
Root Zone pH

– The release of hydrogen ions (H⁺) and hydroxyl ions (OH⁻) by plant roots determine the overall pH of the root zone.

– Generally pH will rise because there is more uptake of anions than cations.
Nutrient Availability & pH

![Nutrient Availability & pH Diagram](image-url)
Proprietary Mixes

Most commercial fertilizer mixes for hydroponics or soilless culture, when mixed according to labelled directions, will give a desirable pH (6.0 – 6.5).
Essential Plant Nutrients

- **Non-fertilizer:**
  - Carbon, Hydrogen and Oxygen.

- **Macronutrient (Primary):**
  - Nitrogen, Phosphorus and Potassium.

- **Macronutrient (Secondary):**
  - Calcium, Magnesium and Sulphur.

- **Micronutrient:**
  - Iron, Manganese, Zinc, Copper, Boron, Molybdenum, Sodium and Chlorine.
Plants take up two ionic forms of nitrogen:

- Ammonium-Nitrogen \((\text{NH}_4^+)\)
- Nitrate-Nitrogen \((\text{NO}_3^-)\)
Urea

- Urea is an organic form of nitrogen.

- It has to be converted by bacteria to ammonium-nitrogen ($\text{NH}_4^+$) before it is absorbed by the plant.

- The ammonium-nitrogen can further be transformed by bacteria to nitrate-nitrogen ($\text{NO}_3^-$) and releasing hydrogen ($\text{H}^+$).
Nitrogen

– Ammonium-nitrogen \((\text{NH}_4^+)\) encourages a soft growth while nitrate-nitrogen \((\text{NO}_3^-)\) gives a more compact and harder growth.

– Fertilizers for soilless culture have very little ammonium nitrogen.
Nitrogen

Ammonium nitrogen and urea will cause acidic conditions in the rooting media while nitrate nitrogen will have a basic reaction.
Plant Prod 7-11-27 contains 7% Nitrogen (6.48% nitrate-nitrogen, 0.52% ammonium-nitrogen and no urea).

Plant Prod 7-11-27

– Plant Prod 7-11-27 will have an alkaline reaction in the soil or substrate.
– The potential basicity is 81.65 kg (180 lbs) calcium carbonate.
– This means that 1 ton of 7-11-27 will have the same alkaline effect as 81.65 kg (180 lbs) of Calcium Carbonate.

Plant Prod 4-18-37

- Plant Prod 4-18-37 contains 4% Nitrogen (3.5% nitrate-nitrogen, 0.5% ammonium-nitrogen and no urea).

Plant Prod 4-18-37

- **Plant Prod 4-18-37**
  - Plant Prod 4-18-37 will have an alkaline reaction in the soil or substrate.
  - The potential basicity is 24.95 kg (55 lbs) calcium carbonate.
  - This means that 1 ton of 4-18-37 will have the same alkaline effect as 24.95 kg (55 lbs) of Calcium Carbonate.

Plant Prod 18-9-27

Plant Prod 18-9-27 contains 18% Nitrogen (8.0% nitrate-nitrogen, 4.0% ammonium-nitrogen and 6.0% urea - nitrogen).

Plant Prod 18-9-27

- Plant Prod 18-9-27 will have an acidic reaction in the soil or substrate.
- The potential acidity is 95.71 kg (211 lbs) calcium carbonate.
- This means that 95.71 kg (211 lbs) of Calcium Carbonate will neutralize the acidic effects of 1 ton of 18-9-27.

Ref: http://www.plantprod.pl/18-9-27.html
Plants absorb phosphorus mainly in the ionic forms, dihydrogen phosphate (\(\text{H}_2\text{PO}_4^-\)) and hydrogen phosphate (\(\text{HPO}_4^{2-}\)) to a lesser extent. (Note: Note the negative charge.)
Phosphorus

– When phosphorous is applied to soil, it becomes “immobile” by firmly binding with clay minerals.

– Due to its immobility in soil or soil based media, most if not all the phosphorus can be applied as a pre-plant.
Phosphorus as a Preplant

For soil-based systems: “.....Typically, pH adjustments and all of the phosphorus required by the crop are applied prior to planting.....”

Reference: Protected Agriculture in Jamaica: A Reference Manual. USAID.
Phosphorus

In soilless mixes, the phosphate anion remains free in solution and can leach out with excess watering.
Micronutrients

– Soil and soil based media will have adequate supplies especially if amended with composted organic matter or manures.

– Deficiencies may show up in soilless substrate due to the requirements of high yielding crops.

– Deficiencies may also show up with the use of greenhouse and technical grade fertilizer mixes that have little impurities.
Nutrient Solutions

– Plants take up nutrients in mutual ratios.

– Nutrient solutions must be formulated to match such ratios and are often termed “balanced nutrient solutions.

– With un-balanced solutions, unwanted nutrients will accumulate in the root zone causing toxic effects.
Nutrient Solutions

Nutrient solutions are formulated based on;

• (a) Type of crop, eg leafy or fruiting.

• (b) Crop growth stage, eg seedling, vegetative or fruiting.

• (c) Crop production system, soil, soilless, water culture.
Calculating Fertilizer Requirement and ppm

Example: How much calcium nitrate to use to get 166 ppm Ca.? Calcium nitrate has 19% Ca and 15.5 % N.

• (Desired ppm) ÷ 75 ÷ (% of Ca expressed as a decimal)

• $166 \div 75 \div 0.19 = 330.27 \text{ grams (11.65 ounces)}/378.54 \text{ litres (100 US Gallons)}$. 
Calculating Fertilizer Requirement and ppm

How much nitrogen (ppm) will be obtained when 11.65 ozs of calcium nitrate in 100 US Gals?

Calcium nitrate has 15.5% N.

• \((\text{ozs/100 US Gals}) \times 75 \times (\% \text{ N expressed as a decimal})\)

• \(11.65 \times 75 \times 0.155 = 135.43 \text{ ppm}\)
### Injection Rate

- 330.27 g (11.65 oz) of calcium nitrate in 100 US gallons will supply the desired 166 ppm.

- If the injection rate is 2.5 : 100, then 330.27 g (11.94 oz) will be dissolved at a rate of every 9.46 L (2.5 US Gallons) in the stock solution tank to compensate for the additional 9.46 L (2.5 gals).

- \((11.65 \div 100) \times 102.5 = 11.94\) ozs

- \(= 330.27\) grams (11.65 ounces)/378.54 Litres (100 US Gallons).
Irrigation Water

– Have adequate water storage.

– Periodically check pH and EC prior to adding fertilizers.

– Use clean water for preparing nutrient solutions.

– If rain water is used, it should be filtered due to dust, pollen or other contaminants from roofs and gutters.
Application Volume/Plant

- For plants that are grown directly in the soil or in framed beds, the volume will be larger than those grown in bags or pots.
Application Volume/Plant

Also depends on the GH climate, the type of media and its properties, size of plant, the number of plants per bag, etc.
Requirements for Fertigation

– High quality water soluble fertilizers.

– Adequate water supply.

– Pump to maintain pressure along delivery lines.

– Stock solution tanks.

– Injector (s)
Requirements for Fertigation

– Primary, secondary and tertiary delivery lines.

– Monitoring devices for pH and EC.

– Device for automatic on/off flow.

– Greenhouse floor suitably designed for lateral or downwards drainage in the event of excess watering, leaks, etc.
Stock Solution Tanks

Two tanks are recommended in order to keep calcium fertilizers away from phosphates or sulphates and prevent precipitation.
Excessive Watering

In open irrigation systems, fertigation must be efficient so as to avoid loss of fertilizers and contamination of underlying soil.
Stock Solution Tanks

Stock solution tanks within the GH should be covered as evaporation of water will add to the humidity of the GH.
Collection Bottle

The installation of a collection bottle along the delivery line will allow monitoring of volumes pumped.
Water Tanks

Water tanks should be in a shaded area so as to avoid pumping warm nutrient solution to plant roots.
Always follow manufacturers advice on use, storage, cleaning and calibrating pH and EC meters.
Other Routine Chores

– Regular check on water and fertilizer supplies.

– Inspection of irrigation lines.

– Servicing of pump and stand-by generator.

– Cleaning of filters.

– Flushing of irrigation lines to remove any precipitation.