# Appendix B. Preparing a Complete Fertilizer Solution

(updated October 2008)

There are many ‘complete’ fertilizer products on the market for use in liquid feeding programs. However, most of the single package dry or liquid concentrate formulations available are unable to supply all the fertilizers required for growth since some of the elements react with one another in concentrated form. Most commonly, calcium will react with the phosphate and sulphate sources to form insoluble precipitates. Magnesium sulphate may also react with other dry fertilizer ingredients. For this reason, calcium and magnesium are often omitted from soluble fertilizer products or they are provided in very small quantities.

For short term potted crops this is seldom a problem. It is not always necessary to feed calcium and magnesium in the fertilizer solution since the dolomitic limestone used to buffer the low pH of most peat based potting soils usually supplies sufficient quantities of calcium and magnesium as the lime slowly dissolves. However, many growers find it useful to supply calcium and magnesium supplements in their feed solutions as well, particularly for hydroponic applications or longer term potted crops. This can be accomplished in several ways:

- If you use a single headed injector system you can occasionally substitute either calcium nitrate or magnesium sulphate (never both together!) for your standard ‘complete’ feed.
- A double or triple headed injector system can be set up to dose calcium and magnesium solutions along with your commercial blend. However, since this will also provide more nitrogen than you may need, you may have to choose a different commercial fertilizer blend to compensate.
- Some companies offer a two or three part fertilizer program that requires separate mixing and concentrate injection to deliver a balanced complete feed that will supply all of the required nutrients when proportioned simultaneously.
- You can make up your own fertilizer solutions from scratch.

There are almost endless variations of liquid fertilizer recipes intended to fit the needs of special crops, conditions, or crop timing. For certain crop situations, the elemental balance, overall concentration (EC), and the effect on media pH can be adjusted by altering the choice of individual constituents, their overall concentration, and their ratios to one another.

The following is an example of a generic complete feed recipe formulated from base fertilizer compounds that are commonly used in greenhouse liquid feeding programs. If the materials are to be mixed in concentrate form for injection (above 15 x the dilute feeding level), it is necessary to separate the calcium nitrate into one concentrate tank (tank A) and the phosphate and sulphate compounds into another (tank B). A third injection tank (tank C) may be required if you need to administer pH adjusting acids or bases. You may come across other variations of this ABC concentrate tank method, but they will almost always keep the calcium nitrate separate from phosphorus and magnesium sources.

## A Generic Complete Fertilizer Formula Suitable for a Hydroponic or Constant Feeding Program

### Recipe for 1000 Litres of Regular Strength (Dilute) Feed Solution**

| Ingredients | Grams for 1,000 Litres of Feed Solution |
|---|---|
| **A Tank:** | |
| Calcium Nitrate | 947 |
| Iron Chelate | 15 |
| Potassium Nitrate (half) | 206 |
| **B Tank:** | |
| Magnesium Sulphate | 350 |
| Monopotassium Phosphate | 174 |
| Potassium Nitrate (half) | 206 |
| Manganese Chelate | 5.8 |
| Solubor | 2.4 |
| Zinc Chelate | 3.5 |
| Copper Sulphate | 2.0 |
| Sodium Molybdate | 0.13 |

| Elements Supplied | Parts Per Million |
|---|---|
| Nitrogen | 200 |
| Phosphorus | 40 |
| Potassium | 200 |
| Calcium | 180 |
| Magnesium | 35 |
| Sulphur | 46 |
| Iron | 2 |
| Manganese | 0.7 |
| Boron | 0.5 |
| Zinc | 0.5 |
| Copper | 0.5 |
| Molybdenum | 0.05 |

**When using an injector system you must divide the final volume desired by the proportioning ratio. For example, using a 100x injection rate, the volume of each fertilizer concentrate tank would be 1,000 litres (final volume) / 100 times dilution. Therefore you would dissolve the fertilizers required for tank A and B into 10 litres of water each.

## Rules for Mixing Soluble Fertilizers:

- Buy greenhouse grade fertilizers for maximum solubility and purity.
- Wear a dust mask and gloves to avoid contact with fertilizer concentrates and dusts.
- Dissolve fertilizers individually in hot water before adding to tanks.
- To avoid the formation of insoluble precipitates, do not mix any fertilizers containing calcium (calcium nitrate) with those containing sulphates (magnesium sulphate) or phosphates (monpotassium phosphate) in their concentrated form.
- Partially fill tanks with water and then mix in the dissolved fertilizer concentrates.
- Precipitates do not normally occur when complete solutions are prepared at low concentrations. Therefore, one tank is usually sufficient for mixing all the ingredients if you plan to make up the fertilizer solution at the dilute feeding rate or at a concentration that is below 15 x. Beyond that, injector systems that proportion concentrates at up to 200 x the final dilute feed level will require 2 or 3 tanks (an A and B tank for fertilizers, and a C tank for pH adjustment) to keep reactive fertilizer materials separate and maintain the proper pH balance.

# Liquid Fertilizer Calculations

To calculate the amount of fertilizer needed for any given quantity of solution:

- $\frac{\text{ppm required / elemental content (fraction) x litres required}}{1{,}000}$ **= grams/litres required**

- **ppm (parts per million required)** - this is the feed concentration (when using blended or 'complete' fertilizers, you normally calculate the amount to dissolve based on the ppm nitrogen required).

- **elemental content of the fertilizer -** the fertilizer label lists the elemental content of each fertilizer constituent as a percentage. For "elemental content" in the calculation, put this percent in the form of a fraction, for example, 20% nitrogen = 20/100 = **0.20**. The only exceptions are for P and K. Since they are always expressed as $P_20_5$ (phosphoric pentoxide) and $K_20$ (potash), they must first be converted to their true elemental content:

  **$P_20_5$ divided by 2.291 = P (elemental phosphorus content)**

  **$K_20$ divided by 1.205 = K (elemental potassium content)**

- **litres required –** the amount of finished (dilute) fertilizer solution you plan to make up. If you plan to use a fertilizer concentrate injector you can calculate the injection ratio after you find the dilute rate (this causes the least confusion).

**Examples:**

- To prepare 500 litres of a 20-20-20 fertilizer at 200 ppm nitrogen concentration:

  $\frac{(200 \text{ ppm} / 0.20) \times 500}{1{,}000}$ = **500 grams per 500 litres**

- To prepare 400 litres (final solution) of calcium nitrate (15.5-0-0-19) at 140 ppm Ca concentration for injection at 200:1:

  $\frac{(140 \text{ ppm} / 0.19) \times 400)}{1{,}000}$ = **295 grams per 400 litres (final solution)**

Since you are going to inject this at 200:1, you will dissolve your 295 grams into 2 litres of water (400 litres finished solution / 200):

**400 litres / 200 = 2 litres**

- You plan to use diammonium phosphate (21-53-0) to supply 30 ppm of phosphorus to a bedding plant feed. Your tank holds 1,000 litres.

  First convert $P_20_5$ to **P** **(53% / 2.291) = 23.1% P**

  $\frac{(30 \text{ ppm} / 0.231) \times 1{,}000 \text{ litres}}{1{,}000}$ = **130 grams per 1,000 litres**