Plants typically grow with their roots in soil and their stems and leaves in the air. They get some of the elements they require from the air (for example, most of the carbon and much of the oxygen used by the plant comes from the carbon dioxide taken in by the leaves of the plant), there are other nutrients that can be fed to them through their foliage, and there are even some aerial plants that get everything they need to thrive without any contact with soil at all. However, most plants get the bulk of what they need through their roots, usually in soil.

In a hydroponic production system, however, instead of getting nutrients from the soil, the plant derives the nutrients it needs from the solution in which its roots are immersed. A fertilizer solution is supplied to the roots, and the way the solution is supplied is important because it influences what components of the air, such as oxygen, are included.

Soil is avoided in specialized controlled-environment systems because it introduces so many composition variables and potential insect and disease problems. Soils differ from one part of a field to another and certainly from one part of the country to another, so fertilization according to soil becomes complex and tricky. Despite this, soil will continue to be the medium most used for agricultural plants for the foreseeable future.

**Source Water**

Water to be used in a hydroponic system should be tested before it is used. It is important to request an irrigation-water report rather than using a domestic-water report, because some elements critical to hydroponic growing will not be measured in a residential water test.

Most water has a certain number of dissolved ingredients in it. In small quantities, most anything dissolved in the water is tolerable. If present in larger quantities, however, some plant usable dissolved ingredients will require that the fertilizer solution be adjusted to include less of those ingredients.

**Calcium and Magnesium**

Calcium and magnesium are often present in source water in significant amounts. Calcium content in source water will range from almost nothing to more than a hundred or two parts per million (ppm). In a few groundwater samples it has been present in excess of 300 ppm, even higher than in most hydroponic fertilizer feed solutions. Magnesium’s presence in water can range from almost none up to 50 or 60 ppm. When magnesium is present at the higher levels, it’s likely that no magnesium will need to be added to the water in the hydroponic feed solution.

Some ingredients that plants require, like manganese and boron, can be present in sufficient amounts to meet plant needs, but can sometimes be present in excess quantities. When these
quantities are present, it is important to add little if any at all in the fertilizer program, since an excess of these substances can damage plants.

**Sodium and Chloride**  
Other ingredients that are highly water-soluble, like sodium and chloride, are often present in groundwater as well as in surface water. Very small amounts of both sodium and chloride are used by plants. Larger quantities can make the water unusable for growing plants hydroponically. When the levels of either sodium or chloride approach 75 ppm in the water, some modifications in the use of the water for hydroponic production may be necessary. If both sodium and chloride are high in the water, plant production problems may develop even at levels lower than 75 ppm.

**Sulphate**  
The sulphate ion is a combination of sulphur and oxygen that acts as a unit in water solutions and in many chemical reactions. It can be present in small to large quantities in source water. Although large quantities of the sulphate ion are tolerable in hydroponic solutions, a point comes when they are high enough in concentration that they don’t leave room in the solution for other needed fertilizer ingredients. Short of that, most plants have a fairly high tolerance for the sulphate ion in the fertilizer solution. Since most fertilizer ingredients are introduced to the hydroponic solution in the form of a salt, the tolerance for a little extra sulphate is a useful attribute in building a soluble fertilizer feed program.

**Treating Source Water**  
When source water is not suitable for hydroponic plant production because of excessive levels of sodium, chloride, sulphate and/or other ingredients, the water can be made suitable for plant production by being processed through reverse osmosis equipment. It is interesting to note that most growers find better plant production results when 10 to 25 per cent untreated source water is blended back into the treated reverse osmosis water. The amount of blend-back will depend on how much of the excess levels of elements are present in the source water.

**Hydroponic Fertilizer Components**  
Although there may be different approaches to developing a fertilizer for hydroponic plant production, only the approach using soluble fertilizer concentrates that can be diluted will be outlined here. In the concentrated fertilizer solution, the calcium must be kept separate from the sulphates and phosphates, so two separate concentrate tanks are needed. Let’s start with the calcium source and look at other fertilizers that are compatible with it in the same solution.

**Calcium**  
The only suitable soluble calcium salt for the concentrate solution is calcium nitrate. Although calcium chloride is soluble, we don’t want to use it because of the addition of the chloride ion. Some fertilizer formulators do use it up to the legal limit for the chloride level in a fertilizer, but even a small amount of chloride content in the fertilizer, combined with chloride that may be present in the source water, could overload the chloride content in the fertilizer program. Using chloride in the fertilizer solution would reduce the variety of source waters usable for hydroponic plant production.
The amount of calcium in your source water can be subtracted from the calcium target for the fertilizer. That level will differ in waters in various parts of the country. Surface water such as that from rivers or lakes will usually contain a low level of calcium, if any. Well water is more likely to contain significant amounts of calcium. That depends, however, upon the rock and other media it has gone through in the ground. This is why it is advisable to have a water analysis done so that you know the calcium and other content of the water. In the U.S., well water in Ohio and Michigan, for example, will usually contain significant to even high levels of calcium. By contrast, well water in Tennessee will usually not contain much of anything in the way of elements. Some of the nitrogen needed by the plants will be provided in the calcium nitrate.

**Potassium, Phosphorus, and Nitrogen**

Potassium sulphate is soluble and usable by plants and can be used in the fertilizer solution. However, it needs to be supplied in the sulfate concentrate tank. The fertilizer of choice is mono potassium phosphate, which is also soluble in water and is used as the source of any phosphorus needed in the fertilizer program. Mono potassium phosphate will need to be supplied in the sulfate concentrate tank as well. Although many growers use phosphoric acid as a source of phosphate, we do not recommend it because it is much easier to manage the fertilizer program if the fertilizer management and the pH management are separated. If a fertilizer containing acid such as phosphoric acid is used, the fertilizer program and the pH management program are tied together, so that a change in one will affect the other, making it much trickier to maintain proper levels of both nutrients and pH.

Once the target amount of phosphate has been determined for the fertilizer recipe, the amount of potassium present in the mono potassium phosphate is calculated and then subtracted from the potassium target, giving us a new target amount of potassium. The amount of potassium nitrate necessary to supply the needed potassium is then calculated. If that results in excess amounts of nitrogen, the potassium nitrate needs to be backed off so that the nitrogen target is not exceeded. When this happens, the potassium target is met by adding enough potassium sulphate to bring the potassium to the target amount.

If the nitrogen target has not yet been met with the calcium nitrate and the potassium nitrate in the fertilizer recipe, the calcium nitrate can usually be increased to meet the nitrogen target. The additional calcium is usually not a problem in the fertilizer program. Magnesium nitrate can also be used if there is room in the program for the nitrogen that would also be supplied.

**Iron**

In the fertilizer solution, iron is supplied in chelated form. The chelating molecule is a large molecule that surrounds the iron and prevents it from chemically reacting with other ions in the solution. This preserves it for uptake by the plant roots. The chelating agent does not interfere with the plant’s uptake of iron.

A number of chelating agents are available. Because EDTA (ethylenediamine tetraacetic acid) is toxic to plants, some growers do not use any EDTA chelates in their recipes. DTPA (diethylenetriamine pentaacetic acid) is a more suitable chelating agent. It protects the iron over a broader pH range. It is a little more expensive than EDTA, but many growers consider the
extra cost well worth it. The DTPA iron is best put into the calcium fertilizer concentrate tank. This keeps it separate from the manganese, copper, and zinc in the concentrate solution.

**Magnesium**
Magnesium is supplied in the sulphate tank. It is usually supplied through Epsom salts or magnesium sulphate. Epsom salts are not very expensive and are readily available. Magnesium can also be supplied in the nitrate form. For most fertilizer programs, however, the nitrogen target has been met by the time magnesium additions are being calculated, so magnesium nitrate is rarely used.

**Micronutrients**
In addition to the above main elements, micronutrients are also needed by plants, but in smaller quantities. These can be supplied in a concentrate mix that is then added to the sulphate fertilizer tank. Manganese, copper, and zinc can be supplied in the sulphate form. Some growers may use one or more of these nutrients in the chloride form, arguing that not much chloride is introduced to the fertilizer program from the comparatively small amount of micronutrient. Other growers use one or more of the nutrients in the EDTA chelated form. This is not a good idea for two reasons: 1) the EDTA is toxic to plants, and 2) the elements in chelated form can move around based on the preference of the chelating agent, making their distribution to the plants unpredictable. For this reason, using chelated manganese, copper, and zinc should be avoided.

Boron can be supplied using boric acid or solubor. Although solubor contains some sodium, the amount of sodium effectively added to the fertilizer solution is small because not much boron is needed.

Molybdenum is usually supplied in either sodium molybdate or ammonium molybdate. A very small quantity of molybdenum is needed in the fertilizer solution, so the amount of sodium or ammonium supplied along with the molybdenum amounts to a small fraction of a part per million in the final fertilizer solution.

**Fertilizer Solution Delivery**
Reservoirs can be used in hobby greenhouses as a source of fertilizer solution for the plants. The feed-strength fertilizer is mixed from the concentrates every day or so and placed in the reservoirs. Although the reservoir can take up space in the greenhouse that could be used for growing plants, and it takes time every day or so to fill the reservoir with feed-strength fertilizer solution, this system requires a much lower investment than the use of fertilizer injectors.

Fertilizer injectors can be used to mix small amounts of the fertilizer concentrates and the pH adjustment concentrate with the incoming source water as it is delivered to the plants. There are several injector systems available. Some are pictured here. Systems can range in price from just over a thousand dollars to four or five thousand or more. The advantages of such systems include the opportunity to supply concentrates that need to be mixed less frequently than a reservoir would need to be filled. The injectors have adjustments that can be used to change the amount of fertilizer in the solution being fed.
A Fertroler can be used in a recirculating system such as Nutrient Film Technique (NFT). The concentrate fertilizers and the concentrated pH correction solution are injected into the plant feed solution as it is recirculated, travelling from the reservoir to the plants and back to the reservoir again. An electrical conductivity sensor and a pH sensor are included in a Fertroler system to monitor and control the EC and pH of the fertilizer solution.

Unless they have a greater than average knowledge and background in chemistry, most hobby growers will want to use a prepared fertilizer blend or have someone work up a fertilizer recipe for them. The information above has been presented to help growers understand the needs, restrictions, and possibilities in supplying what plants need in hydroponics solutions.

http://www.cropking.com/articlehfs