

## Quality of source water for soilless cultures

*Elly Nederhoff*

*CropHouse Ltd, New Zealand*

*Elly@CropHouse.co.nz*

*Published in the Commercial Grower 54(10), 1999, p. 42-43*

Soilless cultures, especially recirculating systems, require water of a very high quality. Both the chemical and the biological aspects are important, but this article is about the chemical quality. The main water sources used in New Zealand are bore water, rain water and water from streams. Bore water often contains significant amounts of compounds, for instance sodium. Recirculation causes the unwanted compounds to build up in the nutrient solution. Poor water quality has an adverse effect on the crop yield and the build-up limits the possibilities of recirculation. These limitations can be overcome in two ways: treating the water for instance by using reverse osmosis, or changing to another source of water for instance harvesting rain water. Both options will be discussed below.

### **Sodium problem**

Bore water in many parts of New Zealand has a high sodium content. When used in a recirculation system, the sodium level will build up continuously. Every time the nutrient solution is topped up to replace transpired water, a new load of sodium is added to the system. Plants largely exclude the sodium, and as a result the sodium does not 'disappear' from the solution, but it accumulates. High sodium levels in the solution reduce plant growth and performance in several ways: lower water uptake, thinner heads, smaller leaves and fruits, unbalanced nutrition, more BER. This all causes a substantial loss in yield.

Guidelines for water quality in recirculating systems are published by Naaldwijk in the Netherlands. Research showed that sodium levels in the root-zone beyond 200 (or 230 ppm) are disadvantageous. The acceptable level depends on the crop. For most flower crops this level is lower. The Naaldwijk recommendations for source water are based on avoiding those harmful levels in complete recirculation (100% closed systems). They also consider the fact that some solid fertilisers are contaminated with sodium. Thus the Dutch criteria for the ideal source water for completely closed systems are very strict: around 15 ppm sodium (= 15 mg/l or 0.6 mmol/l).

In the New Zealand practice, source water with 60 ppm sodium and even much more is being used and also being re-used. However, only partial recirculation is possible. The higher the sodium level in the source water, the less it can be recirculated.

### **Other unwanted elements**

Any element that occurs in source water at a higher content than taken up by the plants, will accumulate. Other elements that can cause problems in source water include calcium, boron, iron, bicarbonate and many more (see Table). Most elements when in excess cause a disturbance of the nutritional balance. Some can cause toxicity, e.g. boron. Other elements are mainly a big nuisance, for instance iron. The iron in bore water is in another chemical form than what the plants take up. This type of iron clogs the irrigation lines, stains everything and can lower the pH. For recirculation, one would prefer to have nothing of this iron at all in the source water, but under some conditions up to 0.3 ppm (300 ppb) can be tolerated. Magnesium, calcium and bicarbonate can cause precipitation and clogging. In addition, bicarbonate buffers the pH. In small amounts this is very useful. In large amounts it disturbs the pH control. On the other hand, the total lack of bicarbonate in rain water makes pH control very difficult.

It appears there are no New Zealand guidelines for source water quality. Therefore we print guidelines from the Netherlands. The table shows maximum levels of compounds in source water that is to be used for complete recirculation. These guidelines are very much on the safe side, as we have seen for sodium.

### Working with poor-quality water

Quite often the water quality is not ideal and alternatives are not available. When the source water contains higher levels of sodium or other chemicals (beyond the guidelines) it can still be used. But it is less advisable to completely re-use the run-off and to have permanent uninterrupted complete recirculation. There are a few practices: re-using only a part of the run-off and blending a little re-use water with a lot of new water, or to allow a certain percentage of the nutrient solution to seep out of the system continuously, or to dump the nutrient solution more frequently. This partial recirculation is a compromise between wasting water and fertilisers and on the other hand build-up of components to harmful levels. It is recommended to take nutrition samples very frequently (in the beginning every week or fortnight) as this will show how quickly the compounds build up. Also watch the crop critically and examine if the crop is performing to its maximum capability.

### Reverse osmosis

When the source water contains excessive salt or other elements or contamination including fungus spores, this can be overcome by intensive water treatment. A possible technique is reverse osmosis (RO), which is based on membrane filtration. The unwanted elements stay at one side of the membrane, and very clean water is obtained at the other side of the membrane. RO is very effective! Obviously, an RO installation requires an investment and brings about costs for energy and maintenance. A serious disadvantage is that RO produces 'concentrate' or 'brine', which is water containing the unwanted compounds in a concentrated form. Typically, only 50% or less of the incoming water is turned into good water, and thus 50% or more leaves the system as concentrate. This huge volume of salt water has to go somewhere. If discharged in an incorrect way, it has an adverse effect on the future land use and water supply. In principle it is harmless to discharge the concentrate into the sea, but consents will be required.

### Storing rain water

Rain water is high-quality irrigation water and it is an ideal substitute for bore water. The rainfall is usually smaller and the water demand is bigger in summer than in winter. Water storage is the key to overcome a shortfall in summer. The obvious way of collecting rain water is from the greenhouse roofs, but the catchment area can also include other buildings and land. It is important that no harmful products (e.g. herbicides) are discharged anywhere near the greenhouse or the wider catchment area. The storage can be a tank for small greenhouse operations, or a pond or dam for large operations. The required size of the water storage can be calculated, taking into account the local rainfall and estimated water consumption, and their distribution over the year. Also any future increase of the growing area and possible changes in weather patterns in future can be considered. If the water storage is really small it is advisable to cover it, which reduces the contamination with pathogens as well as water loss due to evaporation.

### Using different water sources

If water contains compounds that the plants need, they have to be considered when making the nutrient solution. E.g. if water contains calcium, the stock solution need to be made with less calcium. When rain water is the primary source of water, often bore water is the back-up to be used in the event of a dry summer. This is often of a poorer quality. If the change from rain water to bore water is abrupt, then at the same time the make-up of the stock solutions may have to change. It may be needed to partly or completely run to waste while bore water is used. Also the pH control may have to change, as pure rain water has no pH buffering, and bore water often contains bicarbonate which is an excellent pH buffer.

Alternatively, the grower can start mixing stored rain water with bore water long before the storage gets empty. The mixing dilutes the sodium in the bore water and the quality can be perfectly acceptable. Also, a mixture of bore and rain water may have the benefit of a moderate concentration of bicarbonate that stabilises the pH. Note that things can get complicated when there is too often a shift from one water source to another, or when the mixing ratio varies a lot.

## Pathogen control in soilless cultures - part 2

### Pathogens

Pathogen control will be discussed later, but here are some general comments. Bore water can contain pathogens, but usually the pathogen load is relatively low. Stream water and stored rain water regularly contain pathogens, especially in regions with intensive greenhouse cultures and also in pasture areas. Therefore the rain water may need a treatment for pathogen control (see following articles). In fact this is another consequence of changing from bore water to rain water. The positive side of this all is that recirculation will markedly reduce the costs of water and fertilisers, and changing to a better water quality potentially increases the yield.

**Table.** *Levels of chemicals acceptable in source water for complete recirculation. Ppm is part per million, or milligram per litre. Source: DLV, Naaldwijk, The Netherlands. For New Zealand practices see under 'Working with poor-quality water'*

sodium	Na	12 ppm	manganese	Mn	0.83 ppm
chloride	Cl	35 ppm	zinc	Zn	0.46 ppm
calcium	Ca	120 ppm	boron	B	0.22 ppm
magnesium	Mg	35 ppm	copper	Cu	0.65 ppm
sulphate	SO <sub>4</sub>	290 ppm			
bicarbonate	HCO <sub>3</sub>	300 ppm	iron	Fe	(<0.30 ppm)