Water management

# Limited leaching sav

Nowadays there is much interest in 'closed systems'. However, it is often forgotten that there is a 'leak' of some 70% of water supply: that is the water taken up by the crop. A small fraction of that is accumulated into fresh weight; the rest disappears altogether in transpiration. All minerals that the plants do not use will stay behind. When the water used to re-fill the system contains salts, these will accumulate in the 'closed' loop. That shows up as ever increasing EC, and that costs production.

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A high EC means less production, no doubt. With some crops more than with others, but at some point it will be necessary to leach the system to lower the salt concentration.
In this way, the concentration of the salt in the closed loop will increase, until the leaching 'ceiling' is reached and the system is drained. After closing the loop, the concentration will rise again and so on. *Figure 1* shows a real-life example, of time trends of EC in rock wool slabs with a tomato crop grown in closed-cycle, the refill water containing 12 mmol/l of Na, which is rather extreme. The very variable trends in *Figure 1* show that it is difficult to predict how fast the EC will reach the leaching 'ceiling'. This means that, even if about the same amount of water is leached each time, it is difficult to say how often leaching is necessary and how much leaching will take place in total.

## Amount of leaching

The problem with *Figure 1* is that although salinity will increase with time, it is not time that determine what happens. The following example makes it clear. Let's assume a grower has irrigation water with a Na concentration of 2 mmol/l. That will be, obviously, the concentration in the slabs at the start of the crop. Each litre refill brings in another 2 mmol Na. When the crop has taken up the equivalent of the whole volume of water in the system (and all Na has been left behind), each litre has been replaced, and the concentration has doubled to 4 mmol/l, and so on.
So, what determines the rate of increase of concentration is the ratio between cumulated water uptake (U) and the water volume (V) of the closed system, and the resulting concentration is expressed as a multiple of the concentration of the irrigation water, $C_{irr}$. Then it can be calculated that the real water requirement (W, including leaching) is a multiple of crop water uptake, given by:

$$W = C_{MAX} / (C_{MAX} - C_{irr})^{*}U$$

in which $C_{MAX}$ is the maximum allowed concentration in the solution.

The leaching (L) then can be easily calculated as:

$$L = W - U = C_{MAX} /(C_{MAX} - C_{irr})^{*}U - U = U^{*}C_{irr}/(C_{MAX} - C_{irr})$$

For instance, transpiration of a rose crop in the Netherlands is about 1,000 litres per square metre per year. With irrigation water containing 1 mmol/l Na, and

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allowing for a $C_{MAX}$ of 4 mmol/l, the water requirement would be 1333 l/m², of which only 1,000 used by the crop and the rest leached. Tomato is more tolerant for salinity, so a $C_{MAX}$ of 8 mmol/l is prescribed by Dutch environmental regulations. As water uptake of tomatoes (in Dutch greenhouses) is 750 l/m² per year, leaching would be in this case 'only' 107 l/m² per year. This is not only water, but it contains a lot of fertilisers (160 kg/ha nitrogen, for instance, in this example) and, sometimes, plant protection chemicals. It is therefore no wonder that authorities all over Europe try to limit leaching.
In the Netherlands – where closed irrigation systems are in principle mandatory – there are rules indicating for each crop the sodium concentration at which a grower is allowed to leach. Sodium chloride is the most common 'problem' salt in the whole world, by no means the only one.

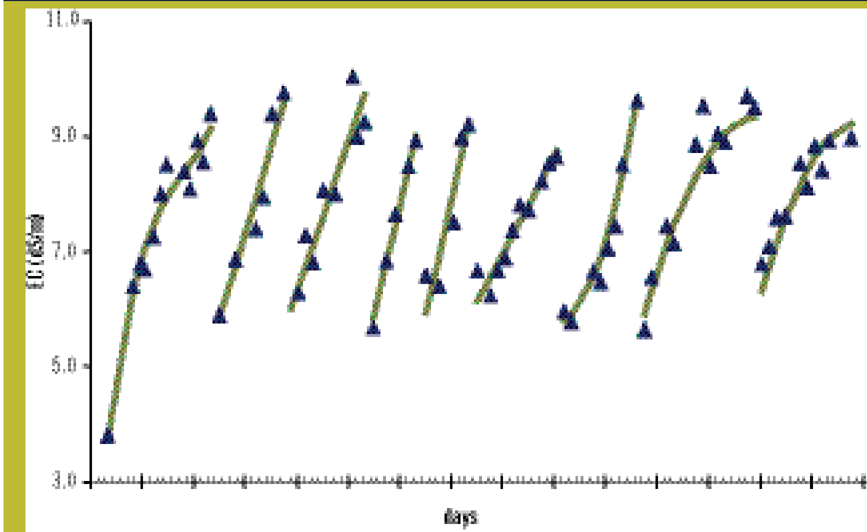
## Costs and benefits

Ideally, the choice of the leaching 'ceiling' (the maximum concentration allowed, $C_{MAX}$) should be based on a cost and benefit calculation, that is: the loss of income (by postponing leaching) due to yield decrease with salinity, against the cost of the water and the fertilisers that would be leached – possibly including a cost of the impact on the environment.
The European project EUPHOROS (see *Box*) is aimed at decreasing the resource use of European greenhouse production and thus limiting the leaching. Therefore, we have calculated the 'optimal' watering strategy for a number of different scenarios (crops, climates, value of produce). Except for very salt-tolerant crops (such a cherry tomato), the result is invariably that there is no advantage in allowing a higher salinity than the irrigation water has. In other words, most closed systems fed with poor quality irrigation water are better not closed at all. In the Netherlands, the environmental regulations therefore compel growers to have good water. Usually this translates into minimal dimensions of a compulsory rain collection basin.

## Value of water

Rain water is cheap, obviously. However, rain water in a basin that occupies land that is otherwise potentially productive, may not be cheap at all. The Dutch Agriculture Economics Research Institute has calculated that the real cost may well exceed €1/m³, which makes other water sources competitive, such as desalinization, or private providers of cleansed surface water. As a cubic metre of water produces anything between for instance 40 kg tomatoes (in Spain) and 80 kg tomatoes (in the Netherlands), even at €1 /m³ water is several times cheaper than what it may produce. Our calculations about the optimal management have shown that – except for very low value crops – it is always worthwhile for a grower to have good water, even if it is more expensive.

**FIGURE 1. TREND OF EC IN THE ROCKWOOL SLABS, OF A TOMATO CROP IN A CLOSED SYSTEM REFILLED WITH WATER CONTAINING 12 MMOL/L OF SODIUM. WHENEVER THE EC REACHED 9 DS/M THE SYSTEM WAS LEACHED AS FAR AS POSSIBLE.**




## Good for the environment

Leaching has a serious environmental impact. In the example of tomatoes leaching only 100 l/m² per year, that means a leaching of 270 kg/ha of potassium and 60 of phosphorus, besides 160 kg/ha of nitrogen. In view of this, irrigation or local authorities willing to reduce agricultural pollution should consider providing incentives for growers to switch either to less salt-sensitive or to more valuable combinations of crops. Then there will be a need for good irrigation water, but also the revenue to pay for it. ■

### EUROPEAN CO-OPERATION FOR A SUSTAINABLE HORTICULTURE

EUPHOROS is a four-year project aiming to develop a sustainable greenhouse system that does not need any fossil energy and which has a minimum carbon footprint. There must be no waste of water nor emission of fertilisers. Substrates have to be fully recycled and the need of plant protective chemicals must be minimal. Yet, this greenhouse system must realise high productivity and use resource efficiently.
The project is a European co-operation between research institutes in Spain, Italy, the United Kingdom and the Netherlands. Also five commercial partners from Latvia, Switzerland, the Netherlands, Hungary and Italy and a Hungarian growers' organisation are participating. To respond to the diversity of climatic, economic and environmental constraints across Europe, techniques will be tested locally in relevant combinations of crops (tomato and/or rose).

The focus is on three main items:
1. Systems to reduce energy, water, fertilisers, pesticide consumption, and waste.
2. Optimising the growing environment.
3. The balance between environment and economy.