some residual, but preferably not much above 1 ppm. The chemical is relatively expensive.

- *Ozone.* Needs moderately expensive equipment to generate ozone (O_3) by electric arc. This is dissolved in water and degrades to oxygen (O_2), which hence has no impact on the nutrient balance. The O_3 needs to be deactivated to below 1 ppm before reuse.
- *Iodine.* This is supplied in cylinders and is relatively expensive. As a package you can be supplied with a cylinder of ion exchange resin to absorb and hence deactivate the iodine. The resin can be recharged when full, but this is an additional cost. You need to take care if you are not using resin, not to dose too high.
- *Hydrogen peroxide (H_2O_2).* In concentrated form this is a particularly nasty chemical, so take great care in handling it. It is relatively expensive, but degrades to form water and oxygen, which is good. It also needs to be deactivated to below 1 ppm before reuse.

UV equipment - It is possible to use low level UV for treatment. The high dosage (high pressure) UV used for full kill is very expensive equipment. Your can buy quite inexpensive UV equipment intended to treat individual household water supplies. However, while these can disinfect very clear water containing easily killed pathogens such as *e-coli*, they are almost useless when treating recycled hydroponic solutions. For example, for these units, which produce UV of intensity 40MJ/cm^2, to effectively treat water, that water must have: over 90% light transmission; low iron; low dissolved solids. A commercial hydroponic UV unit produces UV of intensity up to 250MJ/cm^2, which is enough to kill all pathogens, including viruses, which are the most difficult to kill. The recycled solutions it can treat typically have: 20 to 40% light transmission; high iron content; high dissolved solids – which is a whole different ball game.

One aspect to remember with UV, and to a lesser extent with oxidising chemicals, is that it will destroy the iron in the treated solution. This is worst with EDTA chelate and better with the stronger chelated forms such as DTPA. You can compensate for this by increasing the iron content of your feed.

Heat treatment - There is no low level version of this technique, which involves heating the recycle solution to 95°C and holding for 30 seconds.

Active carbon filter - Active carbon has the property of adsorbing a range of particles, including pathogens. It is moderately expensive to set up; you have no means of telling if it is still active; it is prone to blockage because it can't be back-flushed; and it is expensive to reactivate the carbon. The only units I know of have ceased to be used.

Slow biological filter - This was the original technique used to treat city water supplies from the 1850s. It uses a shallow bed of fine granulated material, usually fine, uniformly sized quartz sand or granulated rockwool. The basis is that a biologically active layer of beneficial organisms builds up and removes the pathogens. The unit is sized to flow for the full 24 hours per day and the flow rate needs to be kept slow enough for it to work. If managed properly it is effective against *pythium*, and most other bacteria, but not viruses or nematodes.

Alternative approach

Another general approach to this problem is for you to not attempt to treat the whole of your recirculating volume, but to bleed off a suitable proportion and treat this to give full kill. You can size the equipment to suit your budget.

Raw water sterilisation

It is important that the raw water coming in to all hydroponic systems is free of pathogens. City water supplies are usually reliable in this regard as is most bore water. However, rain water you collect yourself, water from streams, and especially dam water, will probably be contaminated and should be sterilised. Virtually all the techniques mentioned are capable of doing this well if managed properly and any chemical is deactivated before the water is used. As make-up water, the quantity involved is a tiny fraction of the solution recirculating in an NFT system.

Pythium

In most hydroponic systems there would probably be some small concentration of *pythium* and similar pathogens present in the solution. Provided the plant is healthy and not stressed this is rarely a problem. *Pythium* is usually a 'secondary' infection, that is, it attacks when the plant is stressed or damaged by some other cause, such as a pest, disease, temperature or water stress.

It is important to realise that when the concentration of *pythium* in the system gets high it will attack as the primary infection. In particular, this will be the case when you have obviously diseased plants in the system as you describe in your letter. These will be a continuing source of major infection downstream of these plants, even if you had very effective sterilisation of the recycle stream, which you don't. Consequently, it is vital to remove diseased plants from your system as soon as they are recognised, to limit this impact. Do not put new plants into that system. As soon as all the plants in the channels fed from that tank are harvested, fill the tank with a strong chlorine solution and pump around for several hours to clean the entire system. Make certain that you discard the chlorine solution and flush out the system before replanting.