Reasons for water treatment in soilless systems

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Soilless cultures

Many greenhouse crops are to a large extent produced in 'soil-less' cultures. These are either 'bag' cultures using a solid medium such as pumice, sand, sawdust, peat, bark, perlite, vermiculite, rockwool or a mixture. This can be either in bags, tubes, slabs or troughs, or water cultures ('true hydroponics') including nutrient film technique (NFT) and the less common deep flow technique (DFT) and aeroponics.

Cultures on a growing medium can be either open or closed systems. In an open system, the excess of the nutrient solution runs to waste. In a closed system or 'recirculation system', the excess is drained out and collected for re-use. Many systems are a bit of both: the nutrient solution is recirculating, but is allowed to seep out continuously or is dumped frequently. The solution is topped-up continuously. NFT and DFT are in principle closed systems.

There is a tendency overseas and also in New Zealand towards closed systems. They are the future! Completely closed systems use 20-40% less water and fertilisers than run-to-waste systems. Moreover, closed systems cause less pressure on the surrounding land and water.

Root diseases

Soilless cultures were initially employed as a method to get away from soil-borne diseases (and also to improve plant nutrition). However, it soon became clear that crops in soilless cultures are affected by the same pathogens as crops in soil. Pathogens are fungal structures, viruses, bacteria or nematodes. Pythium, Phytophthora, Fusarium and Rhizoctonia are examples of fungal diseases that also occur in soilless-grown crops. Bacteria, viruses and nematodes can cause diseases in plants both in soil and in soilless cultures.

Such diseases can bring about considerable losses. Either a number of plants are affected and may even die eventually, or nearly all plants are affected to a small degree and perform below normal. A crop can suffer from a disease without showing clear symptoms, and the production can be considerably reduced without being noticed. Any pathogen present in a closed system potentially can spread through the whole greenhouse via the recirculating nutrient solution.

The advantage of soilless cultures above soil cultures is that the roots are confined to a small volume of medium or water, and that pathogens can be controlled relatively easily. The media can be replaced or sterilised after usage. The nutrient solution can be treated, for which there are many different methods available: heating, UV, ozone, hydrogen peroxide, slow sand filtration, biofiltration and more. These techniques will be discussed later in this series.

Plant health and beneficials

Plant health is a complicated balance between a lot of factors: the conditions at the roots (temperature, pH, CF), all conditions affecting plant growth, the plant load, etc., as well as the presence of a pathogen. Some pathogens, Pythium in particular, take their chance when plants are stressed and roots are not in optimal condition. This happens for instance just after planting or when the plants carry a heavy fruit load, and also when another pathogen has already weakened the plants.

Also, it is very important that there is a healthy biological balance at the roots. There is a diversity of bacteria and other micro-organisms living on the roots. The majority of the numerous bacteria are harmless and some are even beneficial. They live from waste and products discharged by the roots. The beneficials compete for space and/or food with the pathogens. So the beneficials can make it hard for the pathogens to establish a population. It is therefore most important to maintain a stable biological environment, and for instance not to kill the beneficials with a chemical drench.

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Chemical, biological and sustainable control

Pathogens can be controlled biologically by introducing beneficial micro-organisms (bacteria or fungi) into the growing system. Several biological control agents are being developed at present, but it may take several years before they work satisfactorily in soilless cultures. Also, growers will have to learn how to use biologicals, just as they have to learn to use IPM. Biological control methods will gain importance and are likely to become standard practice in the future.

In the mean time, something has to be done about root diseases. Ideally the grower employs 'soft' methods that are not based on agrichemicals. Using chemicals has serious disadvantages: pathogens get resistant against certain chemicals and the costs for getting new chemicals are exorbitant; chemical residues may end up in the produce; the environment is disturbed by chemical discharge; chemicals destroy the biological balance on the roots; chemicals are expensive; etc. Therefore agri-chemicals and also chlorine, bromide and iodine are not the preferred way.

It is considered best practice to remove or isolate and/or apply a local treatment to any suspect or sick plant, and to find out which pathogen is involved. The recirculating nutrient solution should be treated to prevent any pathogen being transferred to other plants. The water treatment should be environmental-friendly (not produce chemical waste) and should be soft for the root zone, i.e. not have a residual effect that kills the beneficials on the roots. Some treatments like UV, heat-treatment, bio-filtration and others clearly fulfill these requirements.

Reasons for water treatment

There are various cases where water treatment is needed:

1. source water containing high levels of sodium or other unwanted matter
2. source water containing pathogens
3. run-off (drain) from a bag culture in a recirculating system that may contain pathogens
4. nutrient solution in a water culture (NFT, DFT) that may contain pathogens

Each of these cases may have different requirements. Case 1 is different from the rest, and this will be the topic of the next article. Case 2: source water that is suspect of carrying pathogens can be sterilised with for instance UV, ozone, heating, etc. However, the volume to be treated is about 3 - 6 times bigger, and the running costs will be considerably higher, than in case 3. Most water treatments are applied to run-off (or drain) from bag cultures with recirculation (case 3). The bags (or tubes or slabs) typically drain out 20-30% of the nutrient solution supplied. The run-off may contain pathogens produced on a few contaminated plants. The water treatment aims to remove or destroy the pathogens. NFT or DFT systems (case 4) involve large volumes of nutrient solution to be treated, which is practically impossible.

Decisions, decisions, ...

The first question is whether water treatment is really necessary. This is a matter of risk: how big is the risk of getting a pathogen in the system, or spreading it to other plants, and how big will the damage be? Sometimes the necessity is obvious: when a serious fungal, bacterial or viral pathogen is transferred via water or via the nutrient solution, then a water treatment installation is a necessary measure. In other cases the plants may suffer from a low level of root rot, and a proper water treatment may help to increase the production. Then too a water treatment installation is economically justified. In less obvious cases, water treatment can be compared with fire insurance: one pays the premium every year, and hopes it will never be needed. Some people do without a fire insurance.

Some of the main decisions are:

- Whether to treat the incoming source water, or the drain water or both or none?
- Which technology to choose?
- Which capacity to use?
- To have a storage for the 'dirty' water or the treated water or no storage?
- How to re-use the treated water?

The articles in the coming issues aim to assist with informed decision making.