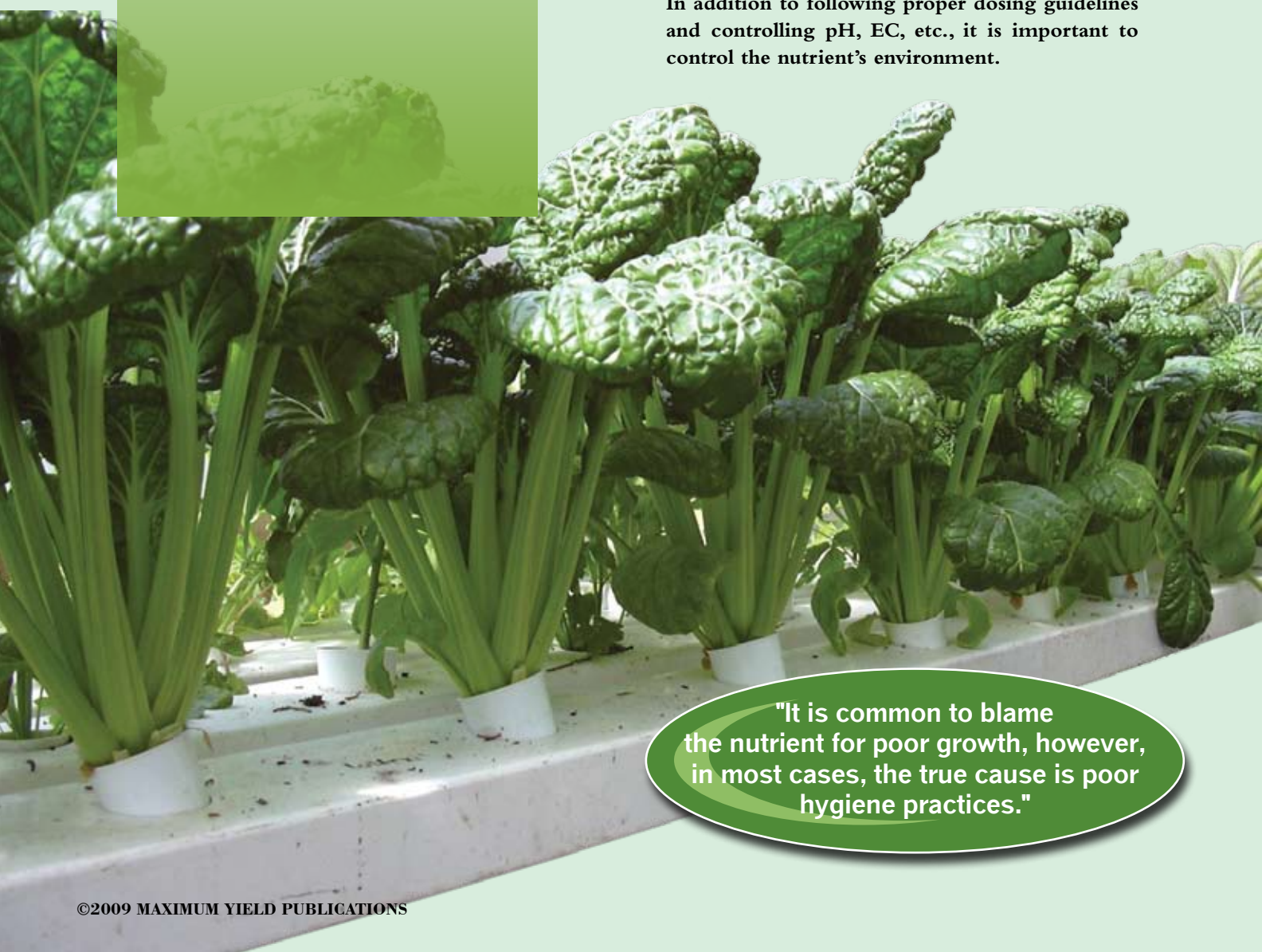
by Andrew Taylor: Chemist of Flairform

NUTRIENT MANAGEMENT

In addition to following proper dosing guidelines and controlling pH, EC, etc., it is important to control the nutrient's environment.



"It is common to blame the nutrient for poor growth, however, in most cases, the true cause is poor hygiene practices."

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Nutrient temperature

It can be beneficial to maintain the nutrient solution temperature within a range of 68-77°F. This will usually be achieved if the air temperature is controlled.

Still too cold? A cold nutrient solution (or cold roots) can lower nutrient uptake. If nutrient temperature remains excessively low, a 'water heater' can be used (figure one).

Too hot? Hot nutrient can cause disease and suppressed nutrient oxygen levels. Small tank volumes can be maintained by placing frozen water bottles directly into the nutrient solution. However, for convenience (or larger tanks), a 'water-chiller' may be required.

In either situation, burying tanks underground will provide insulation against extreme temperatures.

Figure one:
Water heaters (left) are useful for heating nutrient in winter. In summer, 'water-chillers' (right are effective for cooling. These items can be thermostically controlled.

Nutrient disinfection

It is common to blame the nutrient for poor growth results. However, in many cases, the true cause is poor hygiene practices, especially the failure to regularly disinfect the nutrient solution. To prevent disease ingress (*figure two*), the nutrient solution, medium, roots (etc.) should be regularly sterilized. Sterilizing agents must yield a residual chemical when dissolved in the working nutrient solution so that the entire system is treated each time plants are watered. Historically, chlorine dioxide, sodium hypochlorite and monochloramine are used for this purpose. However, monochloramine has the advantage of possessing a long half-life, is gentle on roots and is compatible with the majority of organic mediums and growth promotants.

Figure two:
Root browning is a typical symptom of the root diesease 'pythium'.

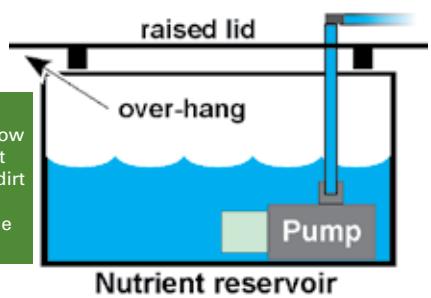
Oxygenation (Aeration) of nutrient

Plants consume oxygen via their roots for the process of respiration. For this to occur, the oxygen must be dissolved in the nutrient solution. This is achieved via aeration.

Aeration methods: As seen with stagnant water, simply exposing a body of water to air does not aerate it. System design generally determines how much oxygen becomes dissolved in the nutrient. Maximum aeration is achieved by breaking the water up into as small a particle size as possible via a tumbling treatment (e.g. waterfall, fountain, etc). In hydroponic systems, aeration can be achieved by:

- Delivering the nutrient solution via spray jets.
- Designing the hardware (for re-circulating systems only) such that the nutrient splashes into the reservoir when it returns from the roots.

Figure three:
A 'raised' lid permits airflow within the reservoir whilst still preventing light and dirt ingress and evaporation. Airflow helps prevent stale air and fungus/moulds.



In either case though, it is critical to ensure that the air is well ventilated where the aeration occurs; otherwise that air will quickly become depleted of oxygen or stale – figure three.

"Air must be well ventilated for aeration to occur; otherwise it can quickly become stale."

An air stone and air pump can also be used. Air stones have the added advantage of promoting circulation of the nutrient reservoir to ensure it is evenly mixed (*figure four*). Make sure to position the pump in a well ventilated area.

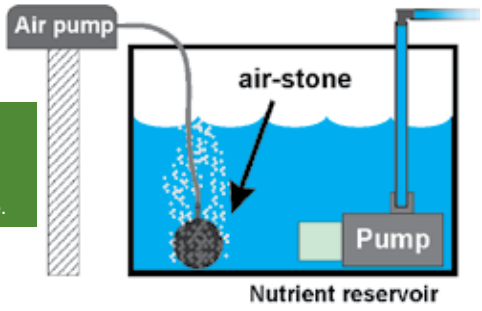


Figure four: Air stones are a reliable method of ensuring oxygen levels are adequate.

Note: Oxygen also aids in keeping the nutrient sterile due to its mild disinfecting properties.

To support optimum plant growth, a nutrient solution generally requires a minimum oxygen concentration of around three milligrams per quart. It is generally noted that super-oxygenation fails to deliver improved growth results.

Also, there is a common belief that high temperatures cause oxygen levels to become inadequate. However, by referring to the table you can see that water can hold seven milligrams per quart of oxygen when at 104°F. Growth problems at higher temperatures could be attributed to photorespiration, increased bacteriological activity, etc.

"Super-oxygenation, as recently noted, fails to deliver improved growth results."

Because new roots are the main supply path for oxygen, if new root growth is restricted then oxygen supplies will be restricted. Hence, when selecting pots/channels, ensure they will accommodate the likely root volume of the plants when at full maturity. Failure to do so may prevent the plants from reaching maturity.

Table One: Oxygen solubility in water using Henry's Law

Temperature (°C)	Temperature (°F)	Oxygen Concentration (mg/L)
0	32	15
10	50	11
20	68	9
30	86	8
40	104	7

Minimize exposure of nutrient and roots to light

Light will accelerate the growth of algae and pathogens. Further, some brands of chelated trace elements can decompose from exposure to UV light, which causes them to become unavailable for root up-take. Therefore, minimize exposure to light as much as possible by placing a lid on the nutrient reservoir, and other regions of the system where nutrient is exposed to direct light.

In achieving this, ensure the design allows adequate ventilation of air otherwise this air will become humid and susceptible to disease. For example, when placing a lid on the reservoir, have it in a raised position so that air can freely enter and exit (figure three).

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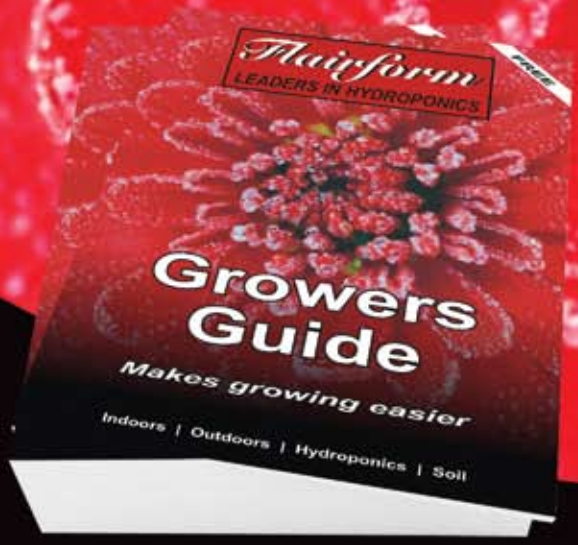

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