FloraMax VegaFlora A+B

Professional 2-part nutrient for commercial cropping in hydro, soil or coco coir.

• Highly pH buffered, balanced and contains no unnecessary ingredients. This helps guarantee better flavors and ensures the nutrient 'runs' clear with minimal salt build-up (scale) in drippers, reservoirs, etc.

• Very simple to use. No tedious dosing procedures - there is no waiting, simply measure, pour then stir. For soil and coco, no pH adjustment is required in most waters.

• Available in 1L, 5L, 20L, 220L and 1,000L.

Root-XS

Produces explosive root growth. Minimizes transplant stress and helps promote a faster crop cycle. Produces greener, healthier foliage and fruits with less signs of stress.

Resin-XS

The #1 BLOOM BOOSTER for serious growers. It stimulates floral blooms and helps promote higher fruit weight. PGR free, and will not induce foul odours or build-ups in the reservoir.

Flowering Enhancer

Three-in-one flowering additive that makes growing easier: **1.** It is a PK additive. **2.** Contains calcium, magnesium and iron i.e. replaces cal-mag additives. **3.** Helps lock pH below 6.5 and improves pH stability by typically 500%.

OrganaBud

Contains Ascophyllum Nodosum sea kelp that is highly soluble. Its 3 year plus shelf-life ensures the nutrient solution remains clear and not cause unwanted build-up in the reservoir or drippers.

Clone Spray

Helps improve vigor of clones and seedlings. Has built-in wetting agent.

System Maintenance

Prevents nutrient by-products and blockages. Compatible with organics.

Silica

Helps prevent leaf wilt and increases weight and shelf-life of fruit.

Cloner

Clone gel. Resists cross contamination. 10 year plus shelf life.

Testimonials

"What I really enjoy about using your line is that the buds don't have a PGR look to them and they look natural, almost organic in their structure. Secondly the bud sites are huge and filled with resin! (USA Commercial consultant)

"When the trichomes pushed out there was easily a third more than normal."

"There have been no set backs at all and i have never seen such steady growth."

Dose charts and calculator at www.floramax.com

System Design: Recirculating or Run-to-waste?

Good system design is vital for producing consistent and reliable growth. What works best depends on factors such as plant type, water quality, maintenance requirements, set-up costs and whether you are growing indoors or outdoors.

RECIRCULATING SYSTEMS

In a recirculating system the nutrient solution is pumped from a reservoir to the plant's roots. The excess nutrient is then allowed to drain back to the same reservoir. This permits reuse of the nutrient solution until it is either depleted of useful elements or is contaminated. The nutrient solution is then discarded and replaced.

There are several types of recirculating systems in use. Popular types include Nutrient Film Technique (NFT - Fig 1.1), Flood & Drain ("Ebb & Flow" - Fig 1.2), aeroponics and satellite systems.

Advantages of recirculating systems

• Lower water and nutrient consumption.
• Relatively easy to disinfect roots and hardware.
• Regular feeding prevents localised salt build-up in the root zone and maintains uniform root zone pH and conductivity.
• Environmentally friendly - minimal potential for localised groundwater contamination.

VegaFlora AB runs very clean and requires minimal pH maintenance

RUN-TO-WASTE SYSTEMS

"Run-to-waste" describes those systems where the excess nutrient or "run-off" is not re-circulated. Conventional 'soil culture' is a type of run-to-waste system. Media with a high water holding capacity are used (e.g. soil, coconut fibre, Rockwool). Feeds are small and infrequent. The 'run-off' is either drained directly onto the ground or is collected (Fig 1.3 & 1.4 respectively).

Irrespective of whether the nutrient is collected or drained directly onto the ground, plain water flushes are usually needed at frequent intervals through the same plumbing. This helps minimize salt build-up in the root zone and also helps keep the feed circuit free of blockages.

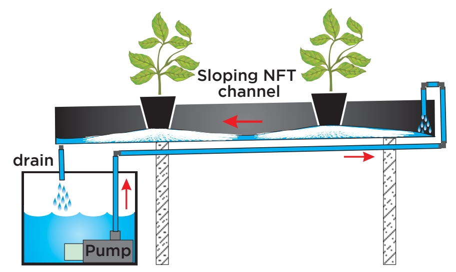

Fig 1.1 NFT system (simplified layout) is a popular type of recirculating system.

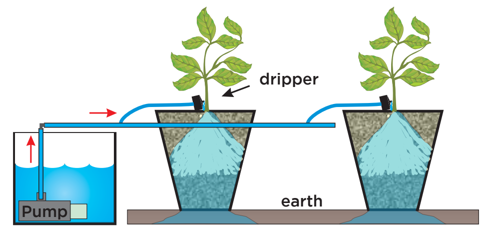

Fig 1.3 Run-to-waste system (simplified layout) where nutrient run-off drains directly onto the ground.

Advantages of run-to-waste systems

• pH and EC of the nutrient feed solution is stable.
• Plants receive fresh nutrient at each feed.
• The use of media having high water holding capacity minimizes the risk of plant death in the event of nutrient pump failure.

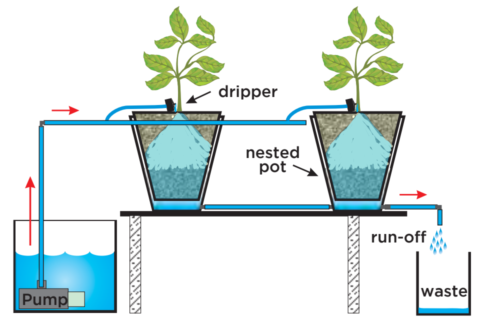

Fig 1.4 Satellite system - Run-to-waste version (simplified layout) where run-off is collected. Note these systems can also be reconfigured into a 'recirculating' mode.

• In the event of root disease outbreak, there is less risk of cross contamination between pots or trays because the nutrient is not recirculated.
• Can be an advantage for higher salinity waters. Unlike recirculating systems, salinity does not build-up in the nutrient solution.

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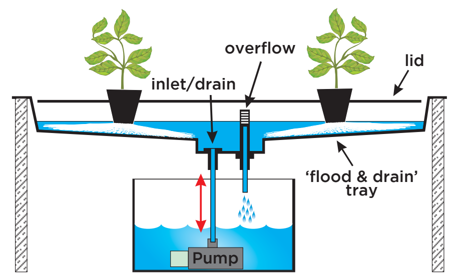

Fig 1.2 Flood & drain system (Basic layout): Diagram shows feed cycle at 'flood'.

Nutrient Management: Creating the perfect nutrient

The performance of a nutrient solution is not guaranteed by simply using a quality brand. Proper dosing procedures and ongoing maintenance are necessary to obtain maximum performance.

1. Use sterile make-up water with low EC. Use either fresh reverse osmosis water (ideal due to its low nuisance salt content) or fresh treated tap water preferably with EC below about 0.2mS.

2. Use a professional liquid nutrient. Use the associated additives as overall performance will usually depend on these. FOLLOW the dosage chart!

3. Add the majority of water before adding nutrients and additives. Never mix nutrients or additives together in their concentrated form. Once a nutrient or additive is added to the water, stir well before adding the next. High pH additives should be added last, pre-diluted into a cup of water before being added then quickly stirred and the pH checked (Fig 13.1a & b).

Flowering Enhancer stabilizes the nutrient's pH below 6.5 and avoids needing to use a cal-mag

4. Measure the nutrient solution's strength (EC) and pH. Check this once the total solution is made and 'before' feeding to the plants. Incorrect pH and EC can have a massive impact on plant performance. See sections "pH Control" and "Conductivity (EC)".

5. Oxygenation of nutrient solution. Plants consume oxygen via the roots for the process of 'respiration'. Oxygen also aids in keeping the nutrient sterile. For these 2 processes to occur, the oxygen must be dissolved in the nutrient solution. This is achieved via 'aeration'. Maximum aeration is achieved by breaking the water up into small droplets via tumbling (e.g. waterfall) or spraying (e.g. fountain). In hydroponic systems, aeration can be achieved by:

• An air stone and air pump. Air stones have the added advantage of promoting circulation of the nutrient solution to ensure uniformity. Make sure to locate the pump in a well ventilated area.

• Delivering the nutrient solution via spray jets.

• Designing the hardware (for recirculating systems only) so that the nutrient splashes into the reservoir when it returns from the roots. In either case though, good ventilation must be provided for the space where the aeration occurs otherwise the air in that space will become depleted of oxygen.

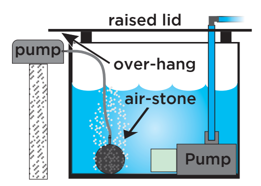

Fig 13.4 A raised tank lid and air stone will help prevent the growth of algae, fungus and slimes and the UV deterioration of vital organics in the nutrient.

6. Nutrient disinfection. It is common to blame the nutrient for poor growth results. However, in many cases the true cause is poor general hygiene practices, especially the failure to treat the nutrient solution. See section "Pest & Disease Control".

Fig 13.1a This is what can happen when an undiluted, high pH additive is added to the working nutrient solution.

Fig 13.1b. Unless pH is quickly corrected to below 6.0-6.5, the precipitate will remain. A similar result can also be expected when other dosing techniques are not followed.

7. Cover the nutrient reservoir! The growth of algae, slimes and pathogens is accelerated in nutrient solutions that are exposed to light. Further, chelated trace elements (and many organic additives!) can decompose when exposed to UV light. This causes them to become unavailable for root up-take. Light exposure can be minimized by placing a lid on the nutrient reservoir.

Ensure to have it in a raised position so that air can freely enter and exit (Fig 13.4). Also, cover other regions of the system where nutrient is exposed to direct light e.g. base of stems and the top of open trays.

Fig 13.5 Water heaters (left) are used for heating nutrient in winter. In summer, 'water chillers' (right) are effective for cooling.

8. Maintaining nutrient and root-zone temperature. The nutrient solution and root zone should be maintained between 20-25 deg C (68-77 deg F). This range offers the best compromise for growth and other factors. Too warm and you risk promoting root diseases or suffocating the root zone with low dissolved oxygen levels. Too cold and you will shock the roots and slow plant metabolism to a crawl.

Given that the optimum air temperature is also 20-25 deg C (68-77 deg F), the temperature of both the nutrient and root zone can be optimized simply by controlling the air temperature to within that range (see secton - "Ventilation"). This is especially the case if the root zone occupies a large surface area and is poorly insulated, such as in NFT channels.

Positioning the nutrient reservoir in a significantly different temperature zone outside of the growing environment may help alleviate the need, or cost, of providing additional heating/cooling in some situations. In extreme climates, extra insulation can be gained by burying reservoirs underground.

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Feeding & Flushing: How often and how much?

FEED FREQUENCY AND VOLUME

Feed requirements will depend on medium and system type, stage of growth, air temperature and humidity.

NFT (no media)

Feed outlet flow rates must ensure the entire root mat is covered. During daylight, the pump can be operated either continuously or intermittently e.g. 10-20 feeds per hour. Feed frequency can be less at night. Be wary of sudden increases in air temperature because increased transpiration and evaporation can cause roots to dry out if under watering or pump failure occurs.

Perlite, Vermiculite, Expanded clay

Water sufficiently to ensure the entire root mat is fed and flushed. Generally feed once every 1-3 hours during daylight, and use a lower feed frequency at night.

Soil / Coco Coir / Rockwool

These media are typically used in 'run-to-waste' systems. As they are prone to water-logging, over-watering must be avoided as it can cause oxygen starvation, pest invasion (fungus gnat), and fungal diseases. Soil and coco coir can be improved in this regard by adding up to 30% perlite or expanded clay. Feed requirements will vary as the plant matures. Some guiding principles are:

Nutrients or plain water: For coco and Rockwool, use nutrients at each watering. For soils with high capacity to retain nutrients (high CEC), it may be beneficial to use nutrients at just each alternate watering. This will help minimize salt build-up and the need for frequent flushing.

Feed times: To avoid water-logging, generally do not feed at night (lights-off period). Begin feeds at the beginning of daylight and cease at least 2 hours before night.

Feed volume: Nutrient feed volume should produce about 10-20% run-off out the bottom of the pot i.e. Collect 10-20ml at the drainage point for every 100ml of feed volume. Run-off helps ensure plants obtain a correct balance of nutrients and that the root-zone and medium is flushed of nuisance salts and thoroughly watered.

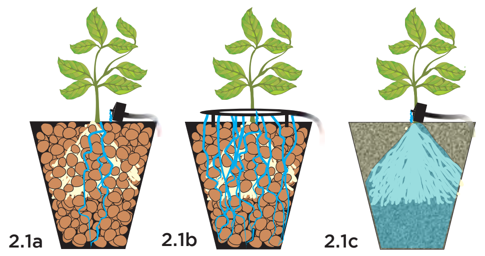

Fig 2.1 Problems with top-feeding: Fig 2.1a Top-fed nutrient moves mainly downwards causing roots off to the side to be unfed and unflushed. Also, if the medium's density is irregular, the nutrient will tend to 'channel' through zones of lower density. This is most evident with coarse media such as expanded clay. This problem can be reduced by delivering nutrient at multiple points via multiple feed outlets or sprayers **(see Fig 2.1b)**, or by using a finer medium such as perlite, Rockwool, coco coir or soil **(see Fig 2.1c)**.

Feed frequency: As a rule-of-thumb, generally feed once per day. To determine if plants are ready for feeding, lift the pot (or slab) to check if it feels light. Alternatively:

• For soil, only feed once the soil feels dry up to about 1 inch (25mm) below its surface.
• For coco, feed if the color of the coco's surface has begun to lighten or feels dry. Note, when plants are more mature (mid-to-late veg and throughout bloom), many growers prefer to feed several times per day. Assuming water-logging and its associated issues are avoided, more frequent waterings help minimize root-zone salt build-up (and lock-out) and the risk of deficiency symptoms.

FLUSHING

Flushing is done to remove deposits of salt precipitates, general dirt and algae from the root zone, medium and other system parts. Pay particular attention to flushing the root zone and feed circuit.

Inspect filters, inlets and feed outlets prior to replenishing the system with fresh nutrient. These are prone to becoming blocked with solid material dislodged during the flushing process.

VegaFlora AB is highly soluble and pH stable which minimizes the chance of "lock-out"

Recirculating systems: Flushing is done immediately after the nutrient is discarded. First, do any necessary manual cleaning, such as the removal of any obvious build-up. Then partly fill the reservoir with fresh water and operate the pump to flush the feed circuit, medium and root zone. Flushing can be enhanced by spraying with a garden hose. Discard the waste, then repeat the process until the waste water is clear and its EC is equivalent to that of the input water.

Run-to-waste systems: As a general rule, coco coir and soil systems should be flushed weekly, and Rockwool flushed every second week. The frequency ultimately depends on factors such as stage of growth, salinity and temperature.

If flushing can be scheduled to occur when the nutrient reservoir is empty, then the existing system hardware can be used. Place low alkalinity water (pH 5-6) in the reservoir and operate the nutrient pump until the EC of the run-off water is no higher than about 0.5mS above that of the water in the reservoir. This is generally achieved once about 3 times the normal feeding volume is used. If the surface of the medium is readily accessible, it can be a beneficial to do additional flushing with a garden hose.

If the nutrient reservoir cannot be emptied to conduct flushing, it is beneficial to have another dedicated reservoir and pump for flushing. This can be connected to the existing feed circuit at a junction controlled by a 3-way valve. The valve is simply diverted to the second reservoir whenever flushing occurs.

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Growers Guide

Nutrient system for commercial cropping

VegaFlora A+B is a professional 2-part nutrient system for commercial cropping in either hydroponics, soil or coco coir.

Analytical Chemists and Horticultural Consultants Since 1966

www.floramax.com **@floramaxnutrients**

Guide to Foliar Spraying: Techniques for spraying

Foliar sprays are useful for delivering fertilizers, fungicides and pesticides to plants.

Foliar sprays can be broadly categorized as either "systemic" or "non-systemic". "Systemic" spays are absorbed into the plant via 'stomata' and then transported via the vascular system to where they are needed (Fig 14.4). Foliar fertilizers and many fungicides are common examples of systemic sprays.

Fig 14.1 Foliar fertilizers can be effective for quickly correcting nutrient deficiency symptoms.

"Non-systemic" sprays are used to treat problems located on the surface of the leaf. Most pesticides are non-systemic. Fungicides used to treat certain types of "surface" fungi such as mildews are also usually non-systemic.

WETTING AGENTS

A wetting agent (or 'wetter') should always be added to foliar spray solutions. Wetters are a plant specific surfactant that improve a spray's capacity to "wet" and penetrate foliage. Where systemic sprays are being used, the spray is able to cover and enter more stomata. This increases the opportunity for absorption (Fig 14.2 & 14.3).

An improper wetting agent can cause problems such as foliar toxicity symptoms and prevent the foliar spray from entering the stomata. In the absence of a wetter, large droplets will form on the leaves. These will either roll off the leaf quickly and be wasted, or may cause burning when intense light is present.

Fig 14.2. Unless a wetting agent is used, foliar sprays will remain as large droplets. This severely restricts their absorption.

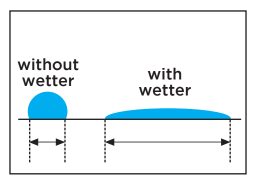

Fig 14.3. Wetting agents lower the surface tension of the foliar spray solution so that the droplet collapses and covers a larger area.

TECHNIQUES FOR FOLIAR SPRAYING

Without proper practice, foliar sprays can be wasted or cause problems such as leaf burn and mould. The following guidelines will help prevent the above mentioned problems from occurring:

1. Test compatibility before spraying the entire crop i.e. Test-spray a small patch of leaves and observe for at least 2 weeks.

2. The best time to spray is usually early morning, about 1 hour before daylight. This gives stomata sufficient time to absorb before light recommences. Spraying earlier than this risks mould growth because the foliage will be damp for a longer period of time.

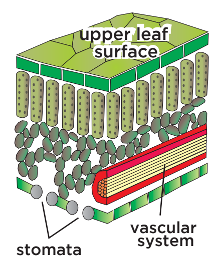

Fig 14.4. Systemic foliar sprays such as fertilizers and fungicides enter the plant via pores called 'stomata'. Ensure to spray the 'underside' of leaves because this is where most of the stomata are located.

3. For systemic sprays especially, avoid spraying when the air temperature is above ~25°C (77°F). Absorption at these temperatures is poor because in many species the stomata are generally closed. Also, the spray can dry too quickly and cause leaf burn and staining.

4. The spray device should be fitted with a nozzle that produces a fine mist. This helps maximize surface coverage, especially on the underside of leaves where the majority of stomata are located. This is also important for non-systemic sprays such as pesticides because insects tend to harbour on the underside of foliage.

5. Spray when wind is minimal. This is especially important with finely atomized sprays because they drift readily. If growing indoors ensure oscillating fans and ventilation units are switched off.

6. Only lightly spray the leaves and stems with a thin film of moisture. There should be little or no run-off. Drenching the surface of the foliage is wasteful and can restrict the stomata's ability to absorb.

Clone Spray is ideal for promoting the growth of seeds and cuttings. It contains a wetting agent and is very gentle on foliage.

7. Use low salinity/ soft water. This will reduce the risk of leaf staining and burning.

8. Where growing outdoors, delay spraying if rain is imminent. If rainfall occurs within 1 hour of spraying, re-spray within the next 1-2 days.

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Optimizing Light Intensity: Guide to lighting

Growing plants indoors under grow lights is very different to outdoor growing. Pay particular attention to the lamp size and type, plant height and density, and the distance between the lamp and foliage.

LAMP SIZE & TYPE

The lamps size (wattage) and type (spectrum) is essential for ensuring plants receive adequate light. When using HID or fluorescent lamps, lux* meters are useful for checking if all foliage is receiving the correct amount of light . Ensure to check both high and low:

• **Clones /seedlings:** 5,000–7,000 lux. Use fluorescent.
• **Vegetative growth:** 15,000–50,000 lux. Use MH lamp.
• **Flowering:** 45,000–70,000 lux. Use HPS lamp.

**PAR meters are more accurate and can also be used to test LED lights, however they are very expensive.*

Too little light?

Can be caused by foliage being too far from the lamp i.e. lamp is too high, or plants are too tall, or area of coverage is inadequate (see below). May also be due to shading from over-planting, inadequate plant shaping/ training, incorrect lamp size/type, or due to a faulty lamp or incompatible ballast. Insufficient light will produce sparse foliage, spindly branches and poor flowering.

Fig 3.1 Lamp selection (from left to right): 'High pressure sodium' (HPS), 'metal halide' (MH), 'strip fluorescents' (SL), 'compact fluorescents' (CFL), LEDs.

Too much light?

Can be caused by the lamp being too close to foliage or incorrect lamp size. Symptoms will be evident on upper most foliage and may include stunted growth, and folding, bleaching or burning of leaves.

Area of coverage

The lamps wattage will largely determine the size of the 'effective' growing area - see Fig 3.3 and Table 3, "Area of coverage". However, to unleash the lamp's full potential, it is critical to also choose a lamp shade that provides maximum reflection efficiency and focuses the light evenly (without hot spots) and with the correct amount of spread i.e. not too wide or narrow. The use of reflective material on walls and other large surfaces helps ensure that light is not wasted through absorption.

TABLE 3: HID lamp specifications (HPS & MH)

	250W	400W	600W	1000W
Area of coverage	0.6 x 0.6m (2 x 2ft)	0.9 x 0.9m (3 x 3ft)	1.2 x 1.2m (4 x 4ft)	1.5 x 1.5m (5 x 5ft)
Minimum gap (Lights to foliage)*	~30cm (12in)	40-50cm (15-20in)	50-60cm (20-24in)	60-90cm (24-36in)

*The minimum gap should generally be increased for young plants including seedlings and those in early veg phase; The gap can be reduced by using air cooled lights.

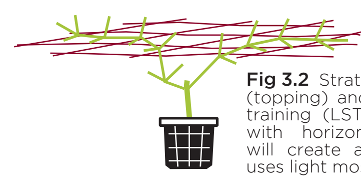

Fig 3.2 Strategic pruning (topping) and low stress training (LST) combined with horizontal netting will create a plant that uses light most efficiently.

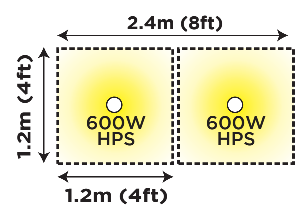

Fig 3.3 From Table 3 we can estimate that 2 x 600W HPS lamps would be suitable for lighting an area 2.4m x 1.2m (4 x 8ft).

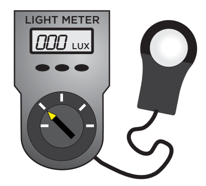

Fig 3.4 Light meters are used to check if all foliage is receiving enough light and if lamps have degraded.

Plant height

Light intensity diminishes rapidly as distance from the lamp increases. Therefore, along with choosing the correct wattage, it is important to ensure the majority of foliage is positioned within lamp's "sweet-zone". This is best achieved by training plants into a low, wide and flat canopy (Fig 3.2) – see section on Topping and LST (Fig 8.1).

Lamp height

To best utilize lamp output, position the lamp as close as possible to the top of plants without causing photo-respiration or burning of foliage (see Table 3 for "minimum gap" guidelines). Air cooled lights should be used because they enable lamps to be positioned closer to the foliage. These are particularly beneficial for 1,000W lamps (Fig 7.2). Ensure lamps are hung so that their height can be easily adjusted as the plants grow.

Plant density / shading

Shading becomes an issue when plants are positioned too close to one another. It is generally more productive to plant fewer plants, rather than more.

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Ventilation: Controlling & optimizing

Ventilation is a key consideration especially when growing indoors under artificial lighting. The combination of lighting and plants generates excessive amounts of heat and humidity which will harm plants if not properly controlled.

EQUIPMENT

Exhaust fan

An inline exhaust fan should be capable of replacing the volume of air in the room in well under 5 minutes. Consult your growshop for the best fan size and type. You will need to account for the room size, configuration of ducting (diameter, length, bends), inlet and outlet filters, the maximum temperature of incoming air and total wattage of all electrical devices in the grow room. Inline fans are generally more effective at pushing air through ducting, as opposed to pulling air. Therefore, especially for long sections of ducting, position the fan at the inlet end, not the outlet (Fig 4.1).

Inlet fan

This is used for pushing air into the room and helps to maximize the effectiveness and lifespan of the exhaust fan. To ensure the exhaust fan's output is not wasted, use an inlet fan of equivalent airflow capacity. With the aid of ducting, you can choose where the incoming air comes from. For example, in hot or cold weather it would be better to draw air from an air-conditioned room instead of from outdoors. However, either way, be careful that the inlet air is fresh and not sourced from the same area where the exhaust air is dumped. Where the incoming air enters the room, do not have it blowing directly onto plants, especially if its temperature is extreme.

Ducting

For maximum fan efficiency keep ducting as short and straight as possible. Where junctions are needed employ 'Y' junctions instead of 'T's.

Oscillating fan

Usually operates 24 hours a day to ensure air is always distributed evenly throughout the room (Fig 4.1). This eliminates 'hot spots' i.e. zones prone to CO_2 depletion or excessive humidity and temperature that are most likely to occur nearest lights and dense foliage. Ensure the fan is blowing air across the top of the canopy that is located immediately below the lamp.

Thermometers and hygrometers

Position the probe in the place of highest temperature or humidity. This is typically directly beneath the lights and amongst the foliage. Where multiple lamps are being used it is best to have a dedicated meter for each lamp.

Growroom height

It is beneficial to have a minimum gap of 1 meter (3 ft) between the lamp shade and the ceiling. Because hot air rises, this space helps shift the maximum temperature further from the plants.

Location of inlet, exhaust and oscillating fans

As a general rule, try to keep the air moving in one direction as this creates and maintains air momentum. Locate the 'inlet' and 'exhaust' at opposite ends of the room, with an oscillating fan maintaining the general airflow direction provided by the inlet (Fig 4.1). For wider rooms especially, employ multiple inlets and exhausts, and space them evenly across the width of the room. This will help ensure all air is replaced. For best airflow, keep objects at least 1 meter (3 ft) away from the fan inlet.

SWITCHING FANS ON & OFF

"Automated" fan switch: Thermostats and humidistats are useful for activating both the inlet and the exhaust fan (Fig 4.1). Position the thermostat's sensor at the hottest point in the foliage, and the humidistat's sensor at the most humid point. Since the optimum night-time temperature is different to that of day, the controller will need to handle two lots of settings.

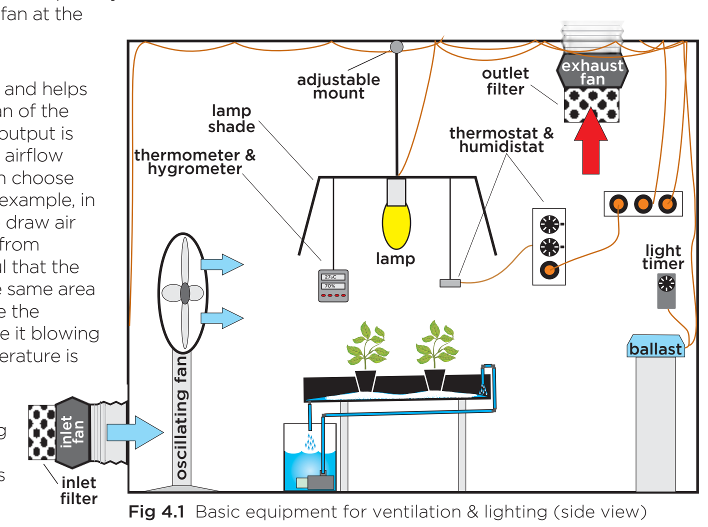

Fig 4.1 Basic equipment for ventilation & lighting (side view)

"Manual" fan switch: A modest degree of control can be gained using a timer - a surprisingly effective aid especially if the weather is consistent or predictable. Control gear such as thermostats, are often not essential in extremely hot or humid climates because it is usually necessary to have fans running constantly anyway.

A fan speed controller is a useful addition where the fan's flow rate is too high during the colder or less humid months.

HOT CLIMATES

If heat is too difficult to control:

1. Shift the 'lights on' period to night.
2. Air-condition the incoming air.
3. Employ air cooled shades.
4. Where the "hot days" are infrequent and the ventilation system is otherwise satisfactory, turn some (or all) lights off during those hot days.

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Cuttings: 10 steps to supercharged cuttings

Reproducing your own plants from "cuttings" provides control over the supply and quality of "seedlings". It also enables you to replicate your favourite 'strain'.

HOW TO PRODUCE CUTTINGS

1. Start with sterile water. This helps prevent diseases. The water should be around 68 deg F (20 deg C).

2. Choose a professional nutrient such as VegaFlora A+B. Add VegaFlora 'A' and stir, then the 'B' and stir.

3. Stimulate root production. Add a root accelerant such as Root-XS to the nutrient solution then stir again. This encourages strong and vigorous roots.

4. Check pH to ensure optimal nutrient availability. Use a calibrated digital pH meter to verify that the nutrient solution's pH is between 5.5 and 6.5. If the pH is above 6.5, add diluted (not straight out of the bottle!) pH Down, little by little until the pH falls within the correct range.

5. Prep pots then moisten. Line two or three-inch net pots with net pot liners and fill with premium quality, pith-rich coco coir and place in a propagator tray (Fig 5.5). Alternatively use large cell trays, coco propagation blocks or Rockwool cubes. Gently tap the pot or tray a few times to get rid of any large air gaps. Thoroughly moisten (flush) the propagation media with the nutrient solution. Discard any run-off.

Root-XS helps accelerate root growth and minimizes transplant stress

TIP: To prevent diseases, ensure all hardware has been thoroughly pre-sterilized with bleach.

6. Take small cuttings. Select a healthy mother plant that is not flowering and has no visible diseases or pest infestations:

• **Step 1. Select "lead" growth tips wherever possible.** Ideal length is 3 – 5 inches with one leaf set (two leaves) at the base that can be removed later on (Fig 5.1). When these lower leaves are removed (in Step 2) this region offers greater rooting potential when placed into 'soil'.

• **Step 2. Work quickly with a sterile, sharp blade** (razor blades are good but be careful). Remove lower set of leaves flush with stem, but without cutting into it. Then cut through the stem on a 45 degree angle about 1/4 inch (6mm) below this (Fig 5.2). Do not tear or crush the stem.

• **Step 3. Insert 1 inch of base of cutting (Fig 5.3) into FloraMax Cloner** (or equivalent). Finally, insert stem about one inch deep into a 'pre-made' hole (slightly undersized) in the centre of the pot or block (Fig 5.4). It should fit snugly. Be careful not to bruise or damage the stem. NOTE: Steps 1 to 3 should be done quickly to minimize stresses on the cutting such as dehydration and air ingress.

7. Seal in moisture. Place propagator lid on tray and generally close any vents (Fig 5.5). Relative humidity should be maintained about 90% (open vents slightly if required). To combat any persistent wilting, spray 2-3 times per day with water or FloraMax Clone Spray. Avoid pools of liquid at the bottom of the propagator – propagation media should never be allowed to sit in water.

8. Place under low intensity fluorescent light. Use 6500K lamps and leave on for 24 hours a day. Monitor temperature inside the propagator using a thermometer with a remote probe. Aim for 75-80 deg F (24-27 deg C). Use a thermostatically controlled heat mat if temperatures are too cold—unlikely. Raise lights if too hot—more likely.

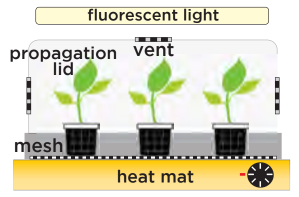

Fig 5.5 A propagation lid, fluoro light and heat mat helps improve the speed of cuttings.

9. Check cuttings regularly. Once roots form (typically after 5 – 10 days) the propagation media can become dry very quickly, often catching growers out. Remoisten using the same solution. In some cases, top-watering fails to water the entire propagation block. Full immersion of the block itself may be required.

10. Be patient and clean. Wait until roots have fully explored the propagation media before transplanting—keeping the cuttings moist (but not drenched) with regular top-ups of mild nutrient solution. Vents can be gradually opened once roots have formed. This will help prevent diseases. Also, maintain hygiene by keeping hard surfaces wiped clean, and remove any dead plant matter as this is an ideal host for fungi.

Clone Spray assists root and foliage growth and helps prevent wilting

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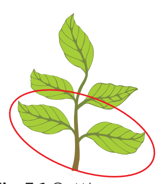

Fig 5.1 Cuttings ideally need "spare" leaves at the base that can be removed later

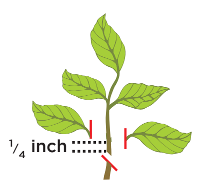

Fig 5.2 Where to cut

Fig 5.3 Insert base of cutting into clone gel

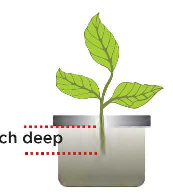

Fig 5.4 Insert base of cutting snugly into medium

Transition to Veg Phase: Hardening-off & transplanting

The ability to move your plants seamlessly from stage to stage without stressing them out is key to achieving optimal yields. Extra care during the early days will pay massive dividends later on. Growers need to be particularly aware of sudden changes in humidity, temperature, light intensity and nutrient concentration.

GROWING FRESHLY ROOTED CUTTINGS (Hardening Off)

1. Opening up propagator lid vents gradually will help wean your rooted cuttings off their high humidity environment and prepare them for life in the main grow room. This process should be done over a few days.
TIP: Eventually placing the propagation lid on an angle will provide a temperature and humidity that is 'closer' to the eventual grow room environment.

2. Air-pruning: Placing your nursery pots or propagation blocks on a mesh and raising them slightly off the bottom of the tray will help your young plants to develop better initial root structures—a technique known as 'air pruning' (Fig 6.1). Air pruning dehydrates and kills any roots that try to grow beyond the propagation block (or pot). This is beneficial because it promotes root growth within the block itself. A block which is fully colonized is more likely to survive planting out into the larger system and provide rapid growth into the vegetative phase.

Fig 6.1 Use mesh to ventilate and 'air prune' the base of seedlings.

3. Do not over-water a fresh transplant. Simply making sure the surrounding medium is moist will encourage the roots to explore. TIP: Make note of how heavy plants feel when watered. Then recheck their weight daily – if they still feel heavy then do NOT water them.

MOVING TO VEGETATIVE PHASE

When are plants ready for transplanting?

1. Clones need to be fully hardened off. Test their capacity to withstand the humidity and temperature used in the 'vegetative phase'. Test for an hour or two to begin with – gradual changes are key!

2. Must be plenty of air pruned roots on the outside of the propagation cube. Do not leave it too late otherwise roots will begin to circle the pot and become root-bound. To inspect roots, gently lift the plant by tapping or squeezing the pot on all sides – particularly from beneath. If there are not many visible roots, or the medium is falling apart, then the plant is not ready for transplanting (Fig 6.3).

Keys for transplanting

1. Try to stage pot size appropriately. A young plant should not look 'lost' in a large pot. Use an intermediate size and allow the roots time to fully colonize all the medium available to them BEFORE replanting into a

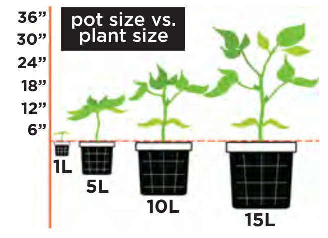

Fig 6.2 Choosing the right pot size is key for enabling roots to fully colonize the medium.

larger pot. Transplanting to an over-sized pot will discourage roots from searching for water. It will also cause the outer medium to become water-logged and prone to water borne diseases such as pythium.

2. Fabric, breathable pots are recommended for use with coco coir or soil. Choose pots with a low, wide form. This will, in turn, encourage squat, wide plants.

3. Ensure that the new medium is flushed and watered with fresh nutrient solution. Note, Rockwool needs to be pre-soaked for up to 24 hours with nutrient solution pH corrected to below 6.0.

Fig 6.3 Never transplant until roots have fully colonized the propagation cube

4. Be careful changing from fluorescent to HID lighting. When transplants / clones are first exposed to HID, avoid stressing them with excessive light. Either use a dimmable ballast, or lift the lights to a 'safe' height e.g. 600W is 3-4 ft (1,000W is 4-5 ft).

5. FloraMax Root-XS and Clone Spray will help greatly to alleviate transplant stress and maximize root growth.

VEGETATIVE PHASE (Veg)

Creating the right environment is essential for promoting vegetative growth (leaves and roots). The right environment will also produce a short and stocky plant - the ideal 'shape' for indoor growing:

1. Metal Halide (MH) lamps are ideal for fast growing plants. They deliver high intensity light (penetrates canopy) with a "blue-rich" spectrum. To avoid stretching, young plants should be positioned close to the light (but maintain minimum safe distance).

2. Vegetative growth is powered by days of 18 hours (typically). 24 hour days can be beneficial.

3. Most species prefer relative humidity of 50-70% and day ("lights-on") temperatures of 68-82 deg F (20-27 deg C). Keep the night temperature cooler but within about 9 deg F (5 deg C) of the day temperature.

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OrganaBud's kelp extract is ideal for all systems including aeroponics

Transition to Bloom Phase: When & how to switch

SWITCHING FROM VEG TO BLOOM

Plants need at least 13 hours of light each day to stay in veg - a few 'long' nights may be enough to trigger budding. Plants begin budding when they get at least 12 hours of 'uninterrupted' darkness each night (12/12). This must continue until harvest. Even if darkness is interrupted briefly, flowering will be hindered. In fact plants may revert back to veg unless 12 hour nights are maintained. Employ a timer to help ensure consistency.
NOTE: For outdoor grows, light deprivation techniques will need to be employed to trigger flowering when nights are too short.

When to switch? There are 2 main considerations:

• **Age of plant:** "Cuttings" can be switched as soon as desired, however, for optimum yields it is generally best to wait until the clone has a strong root system (typically 2-3 weeks old). For "seedlings", if space (and time) permit, better yields can be obtained from a 6-8 week veg period. Alternatively they can be switched straight after germination, however they are biologically incapable of budding until about 3 weeks of age.

• **Height of plant:** Depending on the strain, plants will generally double in size during flowering. So, if 'room' height is limited, the switch to 12/12 will need to be done no later than when the plant has reached 50% of the 'available' height (remember to consider the minimum gap distance between lamp and foliage). Topping and LST (see section) are very useful techniques for keeping plants short and bushy and will help enable a long veg (6-8 weeks) if required.

BLOOM PHASE (Powering the Flower)

As a rule-of-thumb, in the first 2-3 weeks of flowering the plant will continue to grow in height (termed "flowering-stretch") and buds will begin to form. Following this, floral growth will dominate and veg growth will slow then stop. Some general principles:

1. Lights are switched "off" for 12 hours per day – uninterrupted! Use high pressure sodium (HPS) lamps, rich in the yellow-red parts of the lighting spectrum.

2. Increase the air-exchange rate. Flowering plants tend to prefer a gradual lowering of relative humidity to around 40–60% (high humidity can cause rot and mildew). General optimum temperature is 68-82 deg F (20-27 deg C). Also, carbon dioxide consumption is reaching its peak and is therefore often the weakest link.

3. Avoid lamp burn by ensuring to keep foliage at a safe distance (Table 3). Do not keep plants too far away though as this will encourage "stretching".

4. Avoid stressing plants by pruning during flowering unless there is over-crowding or damaged growth. Major 'structural' pruning should be conducted during veg.

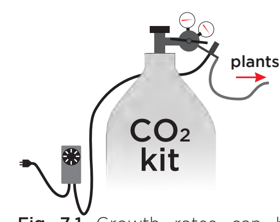

Fig 7.1 Growth rates can be greatly increased by elevating CO2 beyond normal atmospheric levels.

5. Don't get complacent with bugs or diseases such as

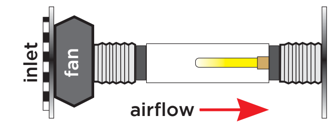

Fig 7.2 The heat from HID lamps is a big problem, especially in summer. 'Ducting' heat away through 'air cooled' lights enables lights to be positioned closer to foliage.

powdery mildew! Regularly check both sides of foliage on all your plants—especially those that sometimes get overlooked in the corner.

AVOIDING THE STRETCH!

Many growers complain that their plants 'stretch' excessively, especially in the first 2-3 weeks of flower. Along with potentially reduced yields, lower foliage will be more difficult to light efficiently, and top foliage is at risk of being burnt if lamps cannot be raised any higher. Plants can also be gangly and weak and therefore susceptible to breaking once loaded with buds. Although "flowering-stretch" is biologically unavoidable, there are ways of minimizing it:

1. Source a strain which is prone to being short.

2. Ensure plants receive enough light. Lack of light causes an additional "stretch" response whereby plants grow taller and with fewer buds. Lack of light can be caused by:

- Shading, due to plants being positioned too close to one another. It is generally more productive to plant fewer plants, rather than more.
- Lamps being too far from foliage will cause plants to 'stretch' to find light. Note, avoid having lamps too close as this will also induce stretching.

3. Use an MH lamp for the first 2-3 weeks of flower, then switch to HPS. The orange/red spectrum of HPS and other "flowering-specific" lamps encourages stretching. Conversely, the "blue" spectrum of MH tends to inhibit stem stretch.

FloraMax Silica helps improve rigidity of stems and helps prevent leaf wilt

4. Keep the night (lights-off) temperature cooler but within about 9 deg F (5 deg C) of the day temperature. Ensure the day temperature is kept below about 82 deg F (27 deg C).

5. Maintain sufficient air flow. This tends to promote shorter, stronger plants.

6. Topping and LST are ideal for modifying the plant to ensure all foliage receives enough light. The majority of this should be done during veg.

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Topping & LST: Achieving perfect form

When growing indoors, higher yields are obtained by training plants into a low, wide and flat canopy. This form promotes more flowering sites, and positions them in the light's "sweet-zone" which is ideal for photosynthesis.

This 'form' can be achieved through a combination of "topping" followed by Low Stress Training (LST). Topping is effectively used to obtain multiple, even-sized floral sites. LST is then used to bring these floral sites to the same height to maximize grow lamp efficiency (Fig 8.1).

STEP 1. Topping

When and how to 'top'?

Topping is best done when the plant is very young (less than 2-3 weeks old) and has only 2-5 nodes in total. Topping is the removal of the plants 'top' growth just above a node (Fig 8.2). Once topped, the two axillary buds immediately below the cut will then grow out into two new branches. Once these new branches grow out to 1 or 2 leaf sets (or nodes) they can be topped again (Fig 8.3a). This second round of topping will grow out to form four even-sized branches (potential bud sites – see fig 8.3b).

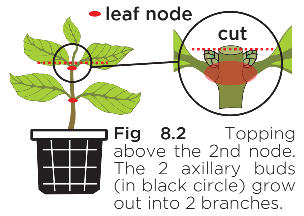


Fig 8.2 Topping above the 2nd node. The 2 axillary buds (in black circle) grow out into 2 branches.

Important points for topping:

1. Topping can be done more than twice however doing so will increase time in vegetative phase. Test to see what is most productive. Some experienced growers will top up to 5 times (or more) to obtain 32 branches and can be well rewarded for their efforts.

2. Healthy plants usually take 2-3 days to recover from topping. Never top during flowering as it causes too much stress. Do not top unhealthy plants. Also, avoid topping older, thicker growth as this takes longer to heal.

STEP 2. Low Stress Training (LST)

After topping (done twice in the scenario above – Fig 8.3b) there are four quality branches (or bud sites) growing vertically from what was originally the top node. LST involves pulling these branches downwards (to horizontal) and outwards (i.e. "star" configuration) so that all four branches are spread apart from one another, horizontal and at the same height (Fig 8.4).

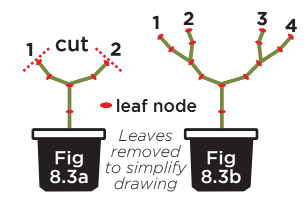
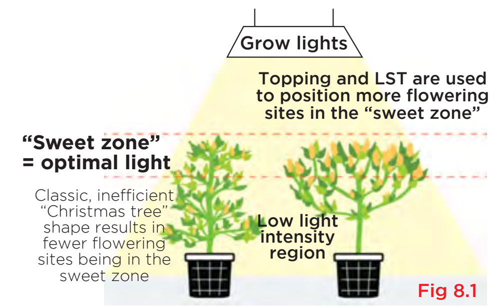


Fig 8.3a A second round of topping will grow out to form 4 even branches (Fig 8.3b).



The lower branches from the nodes 'below' where topping occurred are now also closer and more exposed to the light. As these grow up they can be topped and manipulated using LST.

Important points for LST:

1. When to start and finish LST? LST should be started as soon as possible during the vegetative phase. Flowering phase can commence once all major branches are horizontal and level with each other. Budding can be triggered by switching lights to 12-on, 12-off. LST should continue during early flowering as vegetative growth continues. Maintain a flat, level branch structure. Vegetative growth will eventually stop when the plant is putting most of its energy into flowering. It can be beneficial to remove small, lower growth as this helps improve ventilation through the canopy.

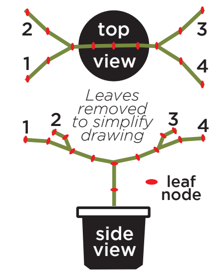


Fig 8.4 LST applied to plant in Fig 8.3b

2. Bending branches: Young growth is easier to bend than older growth. Also some species/ strains are easier than others. Do not rush to get branches horizontal, do this in stages. When a branch is first bent, growth will be slowed. Foliage will re-orientate towards the light then eventually start to grow. LST again once it grows another 3 inches or so.

How to secure branches for LST? For the full article on 'Topping & LST' please go to our Grow Guide at floramax.com

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Resin-XS stimulates floral blooms and helps promote higher fruit weight. PGR free.

pH Control: Adjusting nutrient pH

It is important to maintain the pH of nutrient solutions between 5.0 and 6.5. This helps ensure all nutrients are available for root up-take.

WHEN TO ADJUST pH

The working nutrient pH should be checked at the following times:
1. When the nutrient solution is first made.
2. After the addition of top-up water or additives - especially if either are highly alkaline (Fig 9.1).
3. In recirculating systems, pH should be checked on a daily basis because the uptake of water and nutrients causes pH to change.

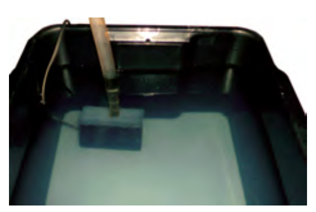

Fig 9.1. This is what can happen to a working nutrient solution when pH is above 7: Calcium, sulfate, copper, iron, manganese and zinc can precipitate on the bottom of the reservoir. In this form and location, they become unavailable to the roots. Precipitates can also cause plumbing blockages. To help prevent precipitation, use a nutrient that possesses a high pH buffering capacity.

HOW TO ADJUST pH

Step 1. Measure the pH: Use an electronic pH meter. Before measuring the pH, ensure that the nutrient is well stirred and that the sampling container is clean.

Step 2. Choose a target pH: It is unnecessary to hold pH at a single point value. So, choose a target pH that provides both a safety margin and minimizes the amount of pH maintenance. For example, if your pH tends to continuously rise (the most common trend), then at each adjustment, reduce the pH to about 5.0 using pH Down. This will give you a much larger pH "safety" margin than, for example, 5.8. If pH tends to fall, at each adjustment increase the pH to about 6.0 using pH Up.

Flowering Enhancer locks pH below 6.5 and reduces pH maintenance at least 500%

Step 3. Adjust the pH: Add a small amount (e.g. 1ml per 50 litres) of pH Down / pH Up. Then stir well and check pH. Repeat this process until the target pH is reached. For pH Up, pre-dilute the dose 100-fold with water before adding.

MINIMIZING pH FLUCTUATION

1. Use a nutrient that is highly pH buffered, particularly when using very alkaline water.

2. For recirculating systems, supply at least 10 litres (2.5 gal) of nutrient for each large plant. Failure to do this will magnify pH (and EC) fluctuations, especially during hot and dry weather when water uptake and evaporation are both excessive. To avoid excess water uptake and high evaporation rates, keep the air temperature below 30 deg C (86 deg F) and relative humidity above 50%.

ELECTRODE MAINTENANCE

Calibrating pH meters: It is essential to calibrate using at least two pH buffers. pH buffer 4.0 and 7.0 are ideal for nutrient solutions.

Dry storage of pH electrodes: This causes dehydration of the glass electrode and the precipitation of salts within the interstices of the frit itself (Fig 9.4). The consequences are slow response times and loss of accuracy and precision. To avoid these problems the electrode tip must be permanently stored (immersed) in a specially formulated storage solution (Fig 9.3). Note, pH buffers 7.0 or 4.0 and distilled water are NOT suitable for this.

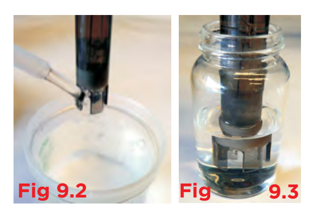

Fig 9.2 Always clean the electrode with distilled water after use. Then keep the electrode immersed **(Fig 9.3)** in a proper "storage" solution when not in use - the No. 1 maintenance tip for prolonged electrode life !

pH electrode contamination: Unless the 'frit' and glass tip of a pH meter electrode is properly rinsed after use, it will invariably become contaminated with impurities (Fig 9.2). This causes similar symptoms to dry storage. Contamination may be so severe that re-calibration is not possible without prior cleaning or replacement. To prevent contamination, always avoid measuring harsh chemicals such as highly caustic solutions (e.g. pH Up and silica additives), or concentrated nutrient.

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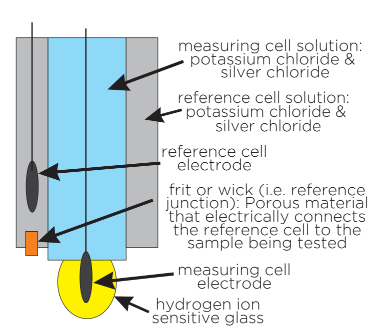

Fig 9.4 Schematic layout of glass pH electrode. Loss of accuracy is invariably explained by different degrees of blockage of the 'frit' or 'wick' - often caused by dry storage, testing of harsh chemicals (e.g. pH Up or concentrated nutrient), or failure to rinse the electrode properly after use.

Conductivity (EC): How to control nutrient concentration

Conductivity (EC) and TDS meters are useful for monitoring the concentration of inorganic nutrient solutions.

CONDUCTIVITY UNITS

Nutrient labels and feed charts quote conductivity values in a variety of units. The most common are 'mS' (short for mS/cm) and 'ppm' (used for TDS meters). Be very careful when dealing with 'ppm' as there are 3 different scales commonly used and if the meter's scale does not match what is quoted in a recommendation, then the nutrient concentration will be grossly incorrect.

USING mS OR ppm

To utilize conductivity recommendations, the grower first needs to know what 'units' the meter operates in e.g. mS/cm, ppm, etc. This will be shown on either the digital display or stamped on the meter's body. Some meter's offer multiple options. If this is the case, choose the option that matches the recommendation e.g. if your growshop recommends 2.2mS in bloom, then switch the meter to read "mS". If the meter does not provide the units specified in the recommendation then it will need to be manually converted (see Table 10.2) e.g. if the recommendation is 2.2mS and the grower is using a Truncheon 700ppm, the target TDS will be 1,540ppm.

USES OF EC IN HYDROPONICS

1. When making nutrient solutions, EC meters are useful for setting the target EC. The EC requirement depends on factors such as the stage of plant growth and the type of medium. Burning of roots or foliage can occur if the EC is too high. If the EC is too low, deficiency symptoms can occur. Refer to Table 10.1 for commonly recommended EC levels for the main stages of growth. Most plant species will generally tolerate being above or below the recommended value by at least 10%.

2. In recirculating systems, EC meters are useful for monitoring and maintaining the target EC as nutrient and water are consumed. If the EC is too low, concentrated nutrient will need to be added to prevent the risk of the solution becoming depleted in any one nutrient element. Be aware that the EC reading is a "gross" figure. It will not warn of an imbalance of nutrient salts, or the accumulation of toxic or nuisance salts (e.g. sodium chloride) which are often present in the top-up water. Therefore, as a precaution, the recirculating nutrient must be frequently discarded and replaced.

HOW TO CHECK AND ADJUST EC

Step 1. Stir the nutrient reservoir thoroughly before sampling. Ensure the sampling container is clean.
NOTE: For recirculating systems, it is easier to interpret EC readings by always ensuring the reservoir is filled to the same volume before taking the sample i.e. if the reservoir level has dropped to half, then the EC reading will be twice as high as what it would be when full (assuming the top-up water contains nil salts).

Step 2. Rinse the electrode in distilled water then immerse it into the sample and record the EC reading. For some meter's, it may be necessary to wait up to a

Table 10.1 General target conductivity (EC) values for different stages of plant growth
(Meter calibrated using 2.76 mS/cm standard)

	Cuts / Seeds	Vegetative	Bloom
Hydroponics	0.6 to 1.0mS	1.6 to 2.0mS	1.8 to 2.5mS
Coco fibre	0.6 to 1.0mS	1.3 to 1.6mS	1.6 to 2.2mS
Soil	0.6 to 1.0mS	1.0 to 1.6mS	1.6 to 2.0mS

Use the lower EC for delicate plants, when air temperatures are above 30 deg C (86 deg F) or when the EC of make-up water exceeds 0.5mS.
EC of raw water must be added to these target EC figures.

minute or longer before the reading stabilizes, especially if the sample's temperature is significantly different from ambient.

Step 3. Adjusting the EC:
a) If the EC is below target, add nutrient until the target is reached (do not use additives for this purpose).
b) If the EC is well above target, dilute with raw water.

Step 4. When finished, rinse the electrode with distilled water. Always store the electrode in distilled water when not in use.

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Table 10.2. Conductivity to TDS Conversions

mS (mS/cm)	cF	Hanna 500ppm	Eutech 640ppm	Truncheon 700ppm
0.5	5	250	320	350
0.6	6	300	384	420
0.7	7	350	448	490
0.8	8	400	512	560
0.9	9	450	576	630
1.0	10	500	640	700
1.1	11	550	704	770
1.2	12	600	768	840
1.3	13	650	832	910
1.4	14	700	896	980
1.5	15	750	960	1050
1.6	16	800	1024	1120
1.7	17	850	1088	1190
1.8	18	900	1152	1260
1.9	19	950	1216	1330
2.0	20	1000	1280	1400
2.1	21	1050	1344	1470
2.2	22	1100	1408	1540
2.3	23	1150	1472	1610
2.4	24	1200	1536	1680
2.5	25	1250	1600	1750
2.6	26	1300	1664	1820
2.7	27	1350	1728	1890
2.8	28	1400	1792	1960
2.9	29	1450	1856	2030
3.0	30	1500	1920	2100

Pest & Disease Control: Fungus gnat, Pythium, etc

Pests such as fungus gnat and diseases like pythium can rapidly spread throughout a system causing severe damge, or even plant death.

The following management practices will significantly reduce the risk of pests and diseases.

1. Maintain good general system hygiene: Diseased foliage should be promptly cut from plants and removed from the growing area along with other waste material. Surfaces must also be kept clean from dust, dirt and spillages.

2. Pest management: Insects feed off plant foliage causing leaves to turn pale and then drop. Some insects target and destroy roots (e.g. fungus gnat - Fig 11.2). They also spread diseases from one plant to another via sap transfer and therefore must be prevented from entering the system. To help achieve this, filter the air supply and minimize traffic into the growing area. To detect the presence of insects, use a magnifying glass to routinely inspect both sides of leaves, stems, medium and roots. "Yellow sticky traps" are also useful as a forewarning (Fig 11.1).

Fig 11.1 A magnifying glass and 'yellow sticky traps' are valuable for detecting the presence of insects.

3. Maintain the condition of the nutrient solution: To achieve this, dose with FloraMax System Maintenance.

4. Humidity: Controlling humidity will prevent spore germination for many diseases. Keeping 'relative humidity' at 50-70% offers the best compromise for both disease prevention and plant growth.

5. Pre-treat make-up water: Untreated surface waters (e.g. dam, creek) and stored water (e.g. rain tank) should be treated prior to use. To achieve this add Pythoff directly to the water at 1.5ml/Gal (0.4ml/L) then stir well. Store this water in the dark and do not use in the system for at least 24 hours. Disregard this treatment process for new tap waters or 'fresh' RO (reverse osmosis) waters.

6. Use a medium with good drainage properties: Poor drainage promotes fungal diseases and pest infestations.

7. Minimize plant stress: Maintain correct water and air temperature, light intensity, nutrient concentration and pH. Doing this will help produce a strong, healthy plant that is best able to defend itself against disease attack.

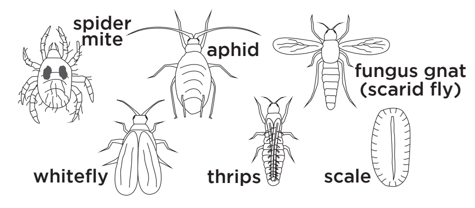

Fig 11.2 Common insects found in hydroponics. Insects spread disease from one plant to another via sap transfer and therefore must be prevented from entering the system.

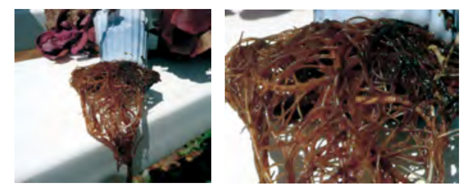

Fig 11.3 Root browning is a typical symptom of the root disease 'pythium'.

8. Clean the system thoroughly between crops. This will help prevent disease problems in the next crop:

• **Step 1.** Remove plants and medium from the system then do as much manual cleaning as possible.

• **Step 2.** Partly fill the reservoir with water and lower its pH to between 4.5 and 6.0. Then, after providing good ventilation for the area and subdued light conditions, add household chlorine bleach (50g/L chlorine) at 20ml/Gal (5ml/L) and mix well.

• **Step 3.** Over a period of 24 hours, run the pump at least once every hour. Note, 'flooding' may be necessary to contact hidden surfaces e.g. underneath the upper surface of channels.

• **Step 4.** Discard this solution then flush the whole system several times with fresh water to remove all traces of chlorine and dislodged material. Where fine drippers and sprayers are used it may be necessary to individually dismantle and clean each unit.

9. Seeds and cuttings: Ensure they are from a reliable source and disease free. Be aware that looks can be deceiving i.e. an incubation period is required for spores to germinate and become recognizable. Also, "unfavorable" conditions can cause diseases to lay dormant until conditions become favorable.

System Maintenance helps maintain the condition of nutrient solutions

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Nutrient Deficiency Symptoms: Diagnosis & Prevention

Monitor plants closely for symptoms of nutrient deficiency. These symptoms can provide a valuable forewarning of serious problems within the growing system.

DIAGNOSING DEFICIENCY SYMPTOMS

The early detection of deficiency symptoms is important because symptoms are often more unique and easier to distinguish when they first appear. Yield loss can also be avoided.
Early detection also prompts the need to check for other possible causes such as excessive humidity and poor EC and pH control.
Note, deficiency symptoms can be easily confused with symptoms arising from insect attack, diseases, under-watering and genetic abnormalities.

Ca-Mg-Fe: The industry's best Cal-Mag. "Bulletproofs" nutrients to pH 9 and helps prevent common deficiency symptoms.

Old or young growth

A key indicator for identifying nutrient deficiency is whether the symptoms are occurring in older growth, younger growth, or both. Mobile elements are able to move out of older leaves and into younger plant parts when a deficiency is present. Hence the symptoms usually occur first in the older (usually lower) leaves. Mobile elements include N, P, K and Mg (see flow chart below).
In contrast, immobile nutrients are not able to move quickly from one plant part to another. Therefore, deficiency symptoms are initially most obvious in younger growth (usually higher up the plant). Immobile nutrients include Ca, S, Fe, Cu, Mn, Zn and B.

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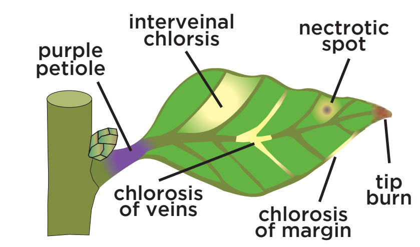

Fig 12.1 Some common leaf abnormalities resulting from nutrient deficiencies.

Chart 12.1 Diagnostic flow-chart for deficiency symptoms

- **Young leaves affected**
  - Terminal buds remain alive but chlorotic (i.e. yellow) or wilted without necrotic (i.e. dead) spots
    - **Copper (Cu)** - Young leaves wilted, without chlorosis - Weak stem tip
    - - Young leaves not wilted - Chlorosis
      - **Manganese (Mn)** - Small necrotic spots - Veins remain green
      - No necrotic spots
        - **Iron (Fe)** Veins remain green
        - **Sulfur (S)** Veins become chlorotic
    - **Zinc (Zn)** - Necrotic spots (large & general) eventually involving veins - Thick leaves - Short stalks
  - Terminal buds die. Distortion & necrosis (i.e. dying) of young leaves.
    - **Calcium (Ca)** Young leaves hooked then die back at tips & margins
    - **Boron (B)** - Young leaves light green at bases, die back from base - Twisted leaves
- **Old leaves affected**
  - Effects are mostly generalised over whole plant. Lower leaves dry up and die.
    - **Phosphorus (P)** - Dark green foliage; Red/ purple colors appear - Lower leaves yellow/ drying to dark green - Stalks become short & slender
    - **Nitrogen (N)** - Light green foliage - Lower leaves yellow/ drying/ brown - Stalks become short & slender
  - Effects mostly localised: - Mottling (i.e. blotches) or chlorosis - Lower leaves do not dry up but become mottled or chlorotic - Leaf margins cupped or tucked
    - **Magnesium (Mg)** - Mottling or chlorosis with yellow around margins & interveinal chlorosis - Necrotic brown spots
    - **Potassium (K)** - Mottled or chlorotic dull grey-green leaves - Small necrotic spots between veins or near leaf tips & margins - Slender stalks