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MAXIMUM YIELD

Features

Dialling In Drip Delivery

by Dr. Lynette Morgan

Reliable and uniform delivery of nutrient solution to every plant in a hydroponic system is essential for obtaining optimal plant growth and yields. With the majority of commercial hydroponic crops grown using drip irrigation, indoor gardeners have long adapted this solution delivery method to small-scale systems and can benefit from advances in irrigation technology.

56

48

Need a Light? Advice on Buying Grow Lights for First-Time Buyers

by Max Bjermo

With so many grow lights on the market, it's hard to separate the good ones from the not-so-good ones. Max Bjermo explains the key things to look for when buying lights on a tight budget.

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It is exciting times to be part of the grow industry, and we look forward to evolving with our Australian readers."

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TG Toby Gorman

Times are changing. When it comes to cannabis, acceptance around the world is growing at an unprecedented rate. In 2018, Canada became the first G20 country to legalise adult-use recreational marijuana and many other nations are working toward similar legislation, including Australia. While many countries are at different stages in allowing the plant to be consumed in one form or another, one thing is certain: growing cannabis in many places will soon be as common as growing tomatoes.

There are benefits to this. As Canada now knows, the marijuana sector creates jobs, innovation, and revenue streams for government. The cannabis plant is the most lucrative on the planet, generating US\$47.6 million per square kilometre in revenue. To put that number in perspective, the third most lucrative plant, tomatoes, generates \$1.4 million per square kilometre (coca is second at \$37.7 million).

In the United States, thousands of socially and economically depressed areas are being brought back to life through economic innovation like Opportunity Zones. These zones allow deep tax breaks for businesses, including cannabis businesses, that choose to locate in these troubled areas, bringing jobs, knowledge, and hope. For farmers, hemp and cannabis are providing exciting new options to grow in their fields or greenhouses.

The upsides are many, though while Canada chose to rush through legislation as a result of election promises resulting in a myriad of distribution, legal, and other problems, Australia is taking a more methodical approach that will hopefully result in a smoother roll-out of legal adult-use cannabis.

With that in mind, in these pages you will find a cannabis-related feature, a first for *Maximum Yield* in Australia. Respecting Australia's laws that it is illegal to grow cannabis at home, we feature Trait Biosciences' ground-breaking discovery of water-soluble cannabinoids (page 68) that highlights innovation within this fast-moving industry.

Of course, you'll also find several how-to-grow features for more traditional crops that include a beginner's guide to buying grow lights, how to identify garden-killing pests, and dialling in drip delivery, among much more.

It is exciting times to be part of the grow industry, and we look forward to evolving with our Australian readers, clients, and partners as the industry changes. ⁽¹⁾



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bare ROOTS

Featured Contributors



Dr. Lynette Morgan holds a B. Hort. Tech. degree and a PhD in hydroponic greenhouse production from Massey University, New Zealand. Lynette is a partner with Suntec International Hydroponic Consultants and has authored several hydroponic technical books. Visit suntec.co.nz for more information.

Contributors

+

Lee Allen **Chris Bond Eric Hopper** Philip McIntosh Shannon McKee



MB Max Bjermo is the lead product developer and indoor growing enthusiast at LEDTonic. Max has tested, modified, and improved LED grow lights to achieve ideal growth and fantastic harvests for all types of indoor gardens. Knowing both hardware and plant biology, Max helps people get the most out of their grow.



A DRIP IRRIGATION



Drip irrigation, also termed micro-irrigation, trickle irrigation, or low volume irrigation, is an efficient method of supplying nutrient solution slowly and directly to the root zone to minimise evaporation/loss. Drip systems can apply nutrient solution either from above or from within the soil.

Low tech versions of drip irrigation have been in use for crop production for centuries. The development of plastic emitters post World War Two revolutionised drip systems; it created a method for water to flow through passageways inside the emitter, helping to prevent clogging and slow the flow of nutrient solution to create a slow drip release pattern. Modern, more-advanced, and widely used flexible drip systems incorporate the use of a wide range of specially designed emitters that allow adjustment of nutrient flow rates. There are two primary types of drip systems: recovery (recirculating) drip systems and non-recovery (non-recirculating) drip systems.

Check out Dr. Lynette Morgan's article on page 48 for more information.

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Rad. You guys always inspiring me to do something I would never have thought about.





Mohmoud A.

Biodynamic farming will be the next trend after the organic era.



@weiler_bull

A tomato plant was my first plant when I started under the stairs with a 9w led grow light from Home Depot. I had tomatoes from the garden in March.



John C. It's a good way to keep things clean especially mold.



Mark S.

Great magazine been reading it over ten years or more I think.

Article Archives

Can't recall that great gardening recommendation from a few months ago? Look it up online. We have hundreds of indoor gardening articles available at *maximumyield.com*.

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ask a **GROWER**

by Eric Hopper

0

I am just starting to grow vegetables hydroponically in my small outdoor greenhouse. As the liquid fertiliser gets used up, how can I maintain the right levels of nutrients in it? How do I know how much fertiliser to add in my continual mixes? And what is "EC level" that you keep referring to? I'm a beginner.

Thank you, Tom

a

hank you for your question. Maintaining the optimal nutrient concentration in a hydroponic system will allow your plants to continue to perform to their full potential. Each nutrient manufacturer has its own suggested nutrient concentration for hydroponic applications. This is usually expressed in either parts per million (PPM), total dissolved solids (TDS), or electrical conductivity (EC). Most hydroponic growers use a monitoring device that expresses the nutrient concentration in the form of PPM or TDS. Parts per million is a form of measurement used to determine the concentration of diluted substances. One PPM is equal to one milligram of substance per litre of water. In hydroponic gardening, PPM or TDS is used to express the amount of nutrients in the nutrient solution. In fact, PPM and TDS are just different terms that actually express the same thing. Even meters that express PPM/TDS measurements rely on electrical conductivity that is automatically converted into a PPM/TDS format. Some of the older meters do not automatically convert the EC values into a PPM or TDS value. If a grower is using an EC meter that expresses the nutrient concentration in EC form, he or she may need to convert the value to a PPM or TDS value in order to compare it to the manufacturer's PPM or TDS recommendation.

As the plants grow and use the individual elements in the nutrient solution, most hydroponic growers simply replace the used solution with a premixed nutrient solution based on the manufacturer's recommendations. This is totally acceptable for the short term. However, because nutrient meters express the total nutrient concentrations and not individual elements, the actual ratio of nutrients to one another may get out of whack over time. If an individual nutrient concentration becomes too low, the plants will not receive all that they need to sustain accelerated growth rates. If a particular individual nutrient gets over-concentrated, it may cause serious burning or lock out issues, which can also lead to nutrient deficiencies. Perhaps the best safeguard against a nutrient solution with an undesirable ratio of individual elements is to do a complete reservoir change every two weeks or so. A periodic, complete reservoir change removes the unbalanced nutrient solution and replaces it with a fresh, balanced nutrient solution. In summary, hydroponic gardeners should invest in a decent nutrient meter to compare PPM or TDS values to the manufacturer's recommendations. To

safeguard against an unbalanced ratio of nutrients that naturally occurs as the plants feed, a hydroponic grower should do a periodic reservoir change. I hope this answers your questions.

Keep on Growing, Eric Hopper

Eric Hopper has more than 10 years of experience in the hydroponic industry as both a retail store manager and owner. He continuously seeks new methods and products that could help maximise garden performance. Eric resides in Michigan where he and his family strive for a self-sufficient and sustainable lifestyle.



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New Agriculture Robot Uses 5G Technology

Chinese researchers have developed a new agricultural robot with 5G technology and sensors that moves between greenhouse rows, collects plant data, and sends it to a control room for analysis by artificial intelligence. The robot's head is equipped with two five-megapixel cameras functioning as its eyes and two seven-megapixel cameras functioning as ears. It has sensors on its head and mouth allowing the robot to detect wind speed, CO_2 levels, humidity, and other data about the environment of a greenhouse. "Currently, the robot can determine the health condition of the plants and decide if they require pest control measures," says Chen Li, deputy director of marketing for the Fujian Newland Era Hi-Tech Co, adding the robot is a prototype and further research is needed to develop robots that can harvest fruits with a bionic hand. The global agriculture robotics industry will be worth \$20.42 billion by 2025.

- freshplaza.com

Urban Gardening a "Cool" Thing

With urban gardening becoming more popular, millennials are taking up the mantle. Gardening expert Frank Ferragine (a.k.a. Frankie Flowers) says it's now a bit of a trend to grow an urban garden as millennials embrace the gardening movement. "A lot are gravitating towards tropical plants and there's been a whole rage over succulents, which are probably the number one photographed plant on Instagram," says Ferragine. "Because we're so attached to our digital screens, taking some time to care for something is appealing." According to studies, gardening offers numerous health benefits, providing stress relief, elevating happiness, and stimulating the brain. "Right now, to be a grower or a gardener is cool," he says. "There's an increase in the number of people wanting to either grow plants indoors, grow their own food, or even grow their own cannabis." Condo and townhome balconies are great for growing flowers, tomatoes, and lettuce.

- canada.com

Study Shows Tomatoes May Reduce Risk of Liver Cancer

A study in the journal *Cancer Prevention Research* states eating tomatoes could be associated with a decreased risk of liver cancer caused by high-fat diets. The health benefits of tomatoes have come to light after a study on mice that showed tomatoes, rich in lycopene (a strong antioxidant, antiinflammatory, and anti-cancer agent), help in effectively reducing fatty liver disease, inflammation, and liver cancer development. "Consuming whole foods like tomatoes and processed tomatoes from sauces, tomato paste, canned whole tomato products, ketchup, and juice, provides the best source of lycopene," says Xiang-Dong Wang, a professor at Tufts University. "We observed that tomato powder is more effective than the same dose of purified lycopene supplementation to prevent liver cancer development." Eating tomatoes and products like tomato sauce rich in lycopene is also associated with a lower risk of cardiovascular disease, diabetes, and certain cancers, the study showed.

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Hydroponic Dandelions Have Role in Rubber Industry

When it comes to ensuring continued rubber supply to manufacture the 50,000 products requiring the resource, dandelions might be the key. Rubber trees in South America are threatened by South American Leaf Blight, and if the disease establishes in Southeast Asia, rubber supply would be lost. However, hydroponically grown dandelions (Buckeye Gold variety has 10-15 per cent rubber in its roots) could help with rubber production. Some dandelions grow rapidly in hydroponics with rubber-producing roots becoming large enough for rubber extraction in a fraction of the time required in fields. Indoor vertical hydroponic systems have potentially at least 10-times higher productivity per acre per year than conventional rubber tree farming and can be built up very quickly. Some US companies are scaling up indoor dandelion production with hopes of ensuring long-term supply while competing with Asian rubber companies.

- thehill.com

Avocado Prices Skyrocket

According to USA Today reports, sky-high avocado prices are causing many restaurants to take the creamy accompaniment off their menus. The "avocrisis" is so bad, Rabobank's vice-president and senior analyst David Magana notes "this is the highest price for this time of the year in at least a decade, probably more." In fact, compared to July 2018, this year's wholesale prices for mid-sized avocados is up 129 per cent (as of July) as the price of a 25-pound box jumped from \$37 to \$84.25. Over the past year, as avocado consumption continued to rapidly increase, production in California and Mexico (which supplies around 80 per cent of American avocados) dropped significantly. In fact, the Mexican government says this "slight drop" in their own production, as well as an "increased demand in the US" has left the country without one of its dietary staples. Mexicans are reportedly resorting to the creation of "mock guacamole."

- delish.com

Key Food-Growing Fertiliser Resource Dwindling

By 2030, the world's population will be 8.5 billion. However, there is a severe conflict between sustainable food production and using non-renewable resources in agricultural systems, particularly phosphate. Phosphorus is a major mineral nutrient required by crop plants for optimal growth and productivity. Phosphate is the only form of phosphorus plants can absorb (as phosphate fertiliser). Phosphate is obtained through rock mining but scientists report global phosphate production will peak around 2030, at the same time the global population hits 8.5 billion people. Several reports have also warned that the global reserve would be depleted within the next 50 to 100 years. Because plants can only uptake small amounts of phosphate, a majority of fertiliser ends up in unwanted places, like bodies of water. It is reasonable to predict that as phosphate becomes more expensive and may eventually run out, it could pose a food-security threat.

– phys.org





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1 FloraMax Resin-XS

Designed to meet the critical demands of growers wanting larger and more potent yields, FloraMax's Resin-XS delivers enhanced resin and oil content, greater potency, and more fruit weight. Growers report more than 30 per cent improvement in trichome population and independent labs have verified significantly higher concentrations of essential oils than other leading products. Clean as a whistle, Resin-XS won't induce foul odours or bio films in the reservoir and contains no plant growth regulators for consumer protection.

2 Cyco Cyclone Rooting Gel

Cyclone is a proven rooting gel that will give your cuttings for clones the best opportunity to thrive and grow through the initial stages of their life. This product accelerates not only root growth but root production as well. Use with softwood (the section of a shrub's stem that's neither brand new nor fully mature) and semi-hardwood (the plant material is between the softwood and woody stage cuttings). Specially for use in the home garden by home gardeners.

3 CANNA Aqua

CANNA Aqua is a userfriendly range of products for outstanding yields on recirculating hydroponic systems. It helps keep pH levels balanced using CANNA's pH Perfect technology, which automatically adjusts your nutrient solution's pH just like magic into the perfect range for optimum growth and bloom. The technology uses a variety of specialised proprietary pH buffers to meet the unique nutritional needs of plants undergoing profuse growing and flowering, so they make larger, fuller fruits and flowers.

4 CenturionPro TableTop

Centurion Pro's Tabletop is considered the smallest, most efficient tumble-style trimmer on the market. At 24 inches long, 10 inches wide and 21 inches in height, it weighs 35 pounds and can be used almost anywhere in your growroom. Don't be fooled by the small size; the TableTop replaces six human trimmers without sacrificing quality. The compact, yet powerful design is capable of processing five to six pounds of dry product (25-30lb wet) every hour.

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★ ESSENTIAL OIL, RESIN AND TERPENE production is increased through high level polyflavonoids and organic plant metabolites that enhance colours, oil and terpene production and increase the overall medicinal value and potency of the plant.

★ PROTIENS AND AMINO ACIDS are essential during the peak metabolic stages of flowering. Bio Diesel contains special L-Amino acids which act as building blocks for protein synthesis, enhanced flower size and overall weight.

★ **COMPATIBLE** with all major programs Bio Diesel does not raise the PPM/EC or change the pH of your solution. It is compatible with all major nutrient programs including PK bloom enhancers. ★ ORGANIC PHOSPHOROUS in the form of fossilized Bat guano is instantly available to the plant and doesn't lockout with other minerals. Beneficial microbe populations are also increased and unaffected compared to detrimental mineral salts.

★ HUMIC AND FULVIC ACID for increased mineral chelation and enhanced nutrient cycling in both hydroponics and soils. These fatty acids make nutrients mobile in the plant and avoids nutrient lockout.





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5 Reiziger Coco Coir Pith

Reiziger Coco Coir Pith is a fast draining, specialty growing medium derived from a blend of premium quality, enriched, and aged Indian coir and pith that accelerates short flowering strains into the generative phase faster - with more yield from the same flowering time. With an optimal mixture of porosity and slightly acidic pH, it is perfectly tailored to hydroponic systems. Because of its ability to absorb twice as much fertiliser, this formula is recommended for plants in a greenhouse or indoor growrooms.

6 Bio Diesel Green Diamond A&B

Another excellent Bio Diesel product, Green Diamond is a two-part grow and bloom base that's specially designed for hydroponic and coco fibre grow environments. It's a complete base that's rich in all micro- and macronutrients required for fast growth and flowering. It's packed with natural chelates and organic plant metabolites, along with pure minerals of the highest quality. Bio Diesel has also added additional trace elements, B vitamins, fulvic acid, and other bio stimulants that work exceptionally well in hydroponic and coco fibre media.

7 | Hy-Gen Coco Starter Pack

For the grower looking at getting started with a great growing medium and nutrients, Hy-Gen's coco starter pack comes with everything. It features one-litre sets of Cocogrow A&B, Cocobloom A&B nutrients and a litre of Budlink silica. Also packed into the box is a pH test kit, as well as key boosters Nitro-K, PK Top Up, Omegazyme, Humiboosta, and Sea Essentials. And it includes two kilograms of compressed cocopeat, which expands to 30 litres, along with a product guide and feeding schedule.

8 Professor's Nutrients Terpene Gold

The Professor's Terpene Gold is a natural, 100 per cent organic additive used during the flowering stage to maximise resin production and enhance aroma, flavour, and quality of a plant's essential oils. Terpene gold has no chemicals and does not compromise on quality or flavour. It increases resin and stickiness in plants, improving overall fruit and flower quality. Terpene Gold will also boost essential oil production with stronger aromatic buds. It's also compatible with all nutrients and is ideal for both indoor and outdoor crops.





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9 FloraMax Roots-XS

FloraMax's Roots-XS is a leading-edge root accelerant that promotes super-healthy vegetative growth and explosive root mass. Growers report stall-free and drama-free transitions through all phases of growth allowing you to get ahead of the curve when transplanting and pruning. Roots-XS runs extremely clean and won't clog drippers, foam up in the reservoir nor create foul odours or biofilms. Furthermore, this organic hybrid additive will not affect the working nutrient pH in the reservoir.

10 | Sol Sense 315W Sol-Unit

The 315W Sol-Unit complete CMH kit is a sophisticated, all-in-one grow light system designed to optimise yield with a lower operating temperature and lower energy consumption when compared to conventional HID grow lights. The in-built 315W digital ballast comprises quality components to deliver a high intensity and full spectrum output. The Sol-Unit includes one 315W, 3,000K CMH grow lamp which produces a higher output compared to conventional HID lamps, so less lamps are needed, less energy is used, and growers save on their operating budget.

11 CANNA Terra Vega

Developed during extensive Dutch field testing, CANNA's Terra Vega is the first single-part nutrient in the hydroponic market specifically developed for cultivation on peat-based mixes and soil. Terra Vega is used during the vegetative phase. It accelerates the generation of lush, early growth on cuttings, seedlings, and transplants resulting in more lateral shoot growth and greater plant biomass. Terra Vega is also an ideal feed for mother plants used for making clones as it's rich in rapidly absorbable nitrogen compounds and pharmaceutical-grade chelated trace elements.

12 Eco Organic Garden Eco Oil

Eco-oil is a registered organic miticide and insecticide that controls a range of problem insects including scale, aphids, twospotted mite, whitefly, mealybugs, and citrus leafminer moths. It's safe for use on vegetable, as well as ornamentals, with no withholding period. Eco Oil is made of 100 per cent plant oils and is HIPPO-enhanced to attract beneficial insects. It's GM free and is very effective at low rater, while being safe for beneficial insects like bees, ladybugs, and earthworms.



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GETTING STARTED IS EASY





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good **TO GROW**









13 Luxx Lighting 1000 DE HPS

The Luxx Lighting 1000 DE HPS grow light boasts the strength and ability to function as a primary flowering lamp with the capability of vegging in a highintensity environment. Bulbs are included and the fixture features 98 per cent highreflective aluminum with a 10-foot 240v power cord. It is controllercompatible via a soldseparately controller. This high-end grow light is backed with a three-year warranty and is available from A-Grade Hydroponics.

14 Ed Rosenthal's Zero Tolerance Pesticide

Ed Rosenthal's OMRIapproved pesticide is a potent mix of food-grade plant oils that eliminate and control spider mites, broad mites, aphids, and powdery mildew. Diluted and used as a repellant, it prevents infestations. Ed's blend of herbal oils fully evaporates, leaving no residue. Zero Tolerance is approved for organic production, is Clean Green Certified, and 100 per cent vegan. As the commercial market becomes more competitive, it is critical that crops test clean.

15 Hy-Gen Sea Essentials

An excellent additive, Sea Essentials is a balanced formulation that encourages flower production and increases root biomass. It is a specially formulated blend of several sea plants, each with itsown unique health-promoting properties and benefits. Sea plants are highly regarded for their amino acid and natural stimulant content. These naturally occurring compounds help promote flowering, nutrient uptake, and support a healthy rhizosphere while encouraging beneficial microbes.

16 CANNA Terra Flores

CANNA's Terra Flores is a complete professional single-part nutrient for fast-growing plants during the blooming phase, specially developed for growing in peat mixes and soil. Terra Flores stimulates fruition and provides every plant with its characteristic flavour. Use Terra Flores for the blooming and fruiting stages of the plant. Rich in elements like potassium, phosphorus, and pharmaceutical-grade chelated trace elements, it guarantees to pack weight and size on your flowers and fruit like no other nutrient can.

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Reliable and uniform delivery of nutrient solution to every plant in a hydroponic system is essential for obtaining optimal plant growth and yields. With the majority of commercial hydroponic crops grown using drip irrigation, indoor gardeners have long adapted this solution delivery method to small scale systems and can benefit from advances in irrigation technology.

rip irrigation, also termed micro-irrigation, trickle irrigation, or low volume irrigation, is an efficient method of supplying nutrient solution slowly and directly to the root zone. While we think of modern hydroponic systems using a range of speciality irrigation equipment as high tech, low tech versions of drip irrigation have been in use for crop production for centuries. The earliest drip irrigation systems consisted of unglazed clay pots filled with water and buried in the soil which allowed water to gradually leak out and irrigate surrounding plants. With the development of accurate plastic molding came the design of drip irrigation system components that allowed further progress with nutrient delivery systems in soilless crops. The development of plastic emitters post World War Two revolutionised drip systems as it created a method for water to flow through passageways inside the emitter, helping to prevent clogging and slow the flow of nutrient solution to create a slow drip release pattern.



Hydroponic Drip Irrigation

Drip irrigation systems for hydroponics come in a variety of forms. The oldest and most basic are porous pipes that may be sub-surface or surface-positioned in media beds. While these are easy to install, they can have issues with uniformity of nutrient solution distribution, are prone to clogging with salts, sediments, and other material, and need to be installed on flat ground. Another inexpensive method of drip irrigation is the use of drip tape that is made from polyethylene of varying thickness and sold flat on reels. Drip tape has holes, slits, or emitters at spacing ranging from 15 to 61 centimetres pre-installed in the product through which nutrient solution is released directly into the substrate. Drip tape technology these days is much more advanced than in the past with designs that help prevent clogged filters and internal emitters that improve reliability and the usable lifespan of the system. While drip tape is more widely used in soil applications than hydroponics, it can be adapted for use in media bed systems. The main issue with drip tape is that it is difficult to control exactly where nutrient is released since the nutrient distribution points are pre-fixed on the tape, so some plants may receive more solution application than others. The inexpensive nature of thin-walled drip tape, however, means this can be replaced with each successive crop and avoids much of the requirement to clean and flush irrigation systems.

"Drippers or emitters control the flow of nutrient to the plant and come in a wide range of different options and can be a little confusing for inexperienced growers."

More advanced and widely used flexible drip systems incorporate the use of a wide range of specially designed emitters that operate at low pressure and allow adjustment of nutrient flow rates. The drip irrigation system typically consists of either a pressurised water supply with nutrient injectors or a central nutrient reservoir with a pump to provide low pressure to the system. Filtration is also commonly included to remove sediment and other material that may block components and emitters in recirculating drip systems. A filter may also be included on the nutrient return system. Drip systems then feed nutrient solution through a main irrigation line or ring out to the cropping area that feeds smaller diameter lateral pipes carrying the solution along the rows of plants. Small diameter drip tubing (also called microtubing or spaghetti tubing) may then be installed into the length of lateral lines.

Top: Drip irrigation is used to deliver nutrient solution to stonewool growing systems. **Middle:** Emitters are positioned close to the plant while avoiding wetting the stem area. **Bottom:** Media bed systems growing a wide range of crops are irrigated with drip systems.



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These each have a dripper or emitter fixed to the end; this is then staked around the base of each plant to hold the dipper in position. These types of systems give maximum flexibility with placement of the emitter allowing for differences in plant spacing to be easily accommodated.

Drippers or Emitters

Drippers or emitters control the flow of nutrient to the plant and come in a wide range of different options and can be a little confusing for inexperienced growers. First, drippers are sized by the volume of nutrient solution they deliver, with most hydroponic drippers being two to 7.5 litres per hour. Drippers are then further divided into pressure compensating and non-pressure compensating. Pressure compensating drippers are more commonly used in largescale commercial hydroponic systems as they are designed to discharge nutrient solution at a very uniform rate under a wide range of system pressures. They deliver the same flow rate irrespective of pressure. These types of emitters are particularly useful in hydroponic systems as all drip emitters will start dispensing solution at the same time and prevent drainage of the solution after the irrigation has been switched off. Pressure-compensating emitters often incorporate a turbulent flow design that helps keep sediment and other particles in motion to help reduce clogging. One of the issues with pressure compensating drippers is that they don't perform well on very low pressures, such as with gravity fed systems.

Non-pressure compensating drippers are the second type of emitter that also has applications for hydroponic systems. These emitters consist of two parts, a central body that is installed into the microtubing, and a screw on top that can be used to adjust the flow of nutrient. By winding the top further down onto the body of the emitter the flow of nutrient can be slowed or increased by winding it up. This allows for emitters in the same system, under the same pressure, to deliver different rates of nutrient flow depending on what is required by individual plants. For smaller hydroponic systems, which often have plants at different stages of development and sizes present at the same time, these are great for making sure larger plants get a higher flow rate than recently planting seedlings. The ability to remove the top of the emitter and see the inside also means that any blockages can be easily cleared out.

How to Run and Monitor Drip Irrigation

Running a drip irrigation system is relatively straight forward, but since plant nutrient requirements change as they grow and develop, some monitoring is always required. A timer is used to control the frequency and amount of irrigation flowing through the drip system and this needs to be adjusted for factors such as plant size, growing conditions, and substrate used. Drip irrigation systems installed into highly moistureretentive substrate such as coconut fibre often need less frequent irrigation than those on free-draining mediums such as expanded clay aggregates or chunky perlite.

Top: Drippers can be held in position with the use of irrigation stakes. **Middle:** Drip stakes help direct nutrient directly down into the root zone. **Right:** Hydroponic tomatoes and similar large fruiting plants are commonly grown with drip irrigation.





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"As plants mature, they require longer irrigations to fully flush nutrients through the substrate and replenish lost moisture levels."

As plants mature, they require longer irrigations to fully flush nutrients through the substrate and replenish lost moisture levels. The easiest way to determine how long to run a drip irrigation system at each irrigation is to time how long it takes for nutrient solution to be seen draining from the base of the substrate of each plant after switching it on. This becomes the set time required at each successive irrigation and frequently changes as the plants grow or as conditions become warmer or cooler.

Issues and Maintenance

The main issue encountered with drip irrigation is the clogging of the emitters with salts, sediments, or other material resulting in uneven flow rates. High-quality water and pre-filtration can assist with some water supplies particularly where sediment, sand, or other organic matter might be present. Iron minerals in some water supplies are also a major contributor to blockages of irrigation equipment and are best removed before using to make up nutrient solutions. Drippers fully exposed to direct light can result in salt deposits accumulating and algae can also grow around emitter outlets causing blockages. In recirculating hydroponic systems where the solution drainage is redirected back to the nutrient tank for further irrigation, particles of growing substrate, pieces of root system, and other organic material can all result in emitter blockages unless suitably sized filters are installed on the system. To avoid these issues resulting in plant growth problems, drippers should be regularly monitored while the irrigation is on to ensure all are working correctly. Blockages can often be cleared by tapping the dipper to loosen any sediment, and accumulated salts can be removed by submerging the dripper in hot water for a few minutes to dissolve any deposits. Stubbornly clogged emitters may need to be replaced so keeping a few spares on hand is always advisable. Between crops, or at least once a year, drip irrigation systems can be cleaned with acid to remove salt deposits, algae, and bacteria.

Drip irrigation systems, if well designed and maintained, are a highly efficient nutrient delivery method for hydroponic substrate systems. Even those with existing systems often benefit from trialling different types and styles of emitters to determine which is the most reliable and easy to maintain in their hydroponic garden. ⁽¹⁾

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ADVICE ON GROW LIGHTS FOR FIRST-TIME BUYERS

by Max Bjermo

With plenty of LED grow lights to choose from, it's hard to find the best value for the buck. Max Bjermo offers some insights in finding good lights on a tight budget.

t's a real jungle out there. There are just pages and pages with LED grow lights of various shapes, forms, sizes, and prices. Some brands make ridiculous and confusing claims about their lights. Other brands withhold crucial information, which makes it difficult to compare one light to the other.

This article explains the basics to understanding grow lights and the most common terms used when measuring and comparing specifications and performances.

The focus will be on lights in the lower end of the LED grow light price range. After reading this article, you should be able to distinguish poorly built LED grow lights from good LED grow lights.

General Awareness of LEDs

The first tip? Look up the brand, including its website, social media, and online reputation.

If you're going to spend a significant amount of money on a grow light, you want to be sure you're buying it from a good and reliable source. When you find an interesting light on Amazon, for instance, look up the brand elsewhere. Do they have a website? Do they have social media channels? Can you reach them on Facebook or by email? A complaint often found in the business is that some brands don't reply to customer questions or emails. I feel that a fairly expensive product should also come with good after-purchase care.

One more thing: a high review count on Amazon doesn't always equal a good product. As several news sites report, there are plenty of fake or bought reviews floating around on Amazon. Apply critical thinking!

Location, Location, Location

It's no secret the American and European online marketplaces are getting flooded with brands from all over the world, primarily China. While "Made in China" doesn't reflect a product's quality (even our expensive phones, laptops, and TVs are made in China), it speaks a lot about the seller and the way they do business. It's usually easy to get an idea of the seller's location and origin simply by looking at a product's description, including product/listing title, images, and the describing text. Phrasing, sentences, and grammar will be a bit off with brands that don't have a North American, Australian/New Zealand, or European home base.

If a product looks generic and the same (or very similar) to a design that's used widely across different brands, it's also a common sign of a suspect brand. While a seller's base isn't necessarily a deal breaker, it leads to the next point.

The Seller's Knowledge

Do the sellers know what they're talking about? Do they grow themselves?

Manufacturing a light is not that difficult. However, putting together a light that is good and efficient is more challenging. A grow light should be practically tested and used to determine how well it works. In many parts of the world, China for instance, growing cannabis is a big no-no. Some plants (tomatoes) have very similar characteristics to marijuana and could, to some extent, be used as a substitute test plant, but even this is done at a very small scale.

Find a brand that knows what they are doing, knows how to grow, and knows the product they are selling. There's quite a lot that goes into making a good light. If a brand can't present their product well, it's a sign that they don't fully understand it or its use.

Reliable Information and Specs

It's easy enough to write "1,000W Grow Light," "Super High PPFD/PAR," or similar claims online. Consumers rarely try to verify this. Expensive testing equipment such as Apogee quantum meters are required to accurately measure light intensity (PPFD), but they aren't an economically viable option for small-scale grows or hobby growers.

One suggestion is to cross-reference the specs and information on as many different sites and places as possible. Ideally, you'll want to see videos of live recordings and testing, or testing by independent users that are knowledgeable in the field.



•• Understanding the basics of

how lights work and knowing what numbers to look for is necessary for you to make a smart purchase decision." 66

Many grow light manufacturers opt to have a colour spectrum of primarily or even exclusively blue and red light. While this will produce the maximum amount of light output, this spectrum is very imbalanced and not ideal for plants or for your eyes." It's also important to know which values to look for. A typical misleading trick is to boast wattage claims of 1,000W, 1,500W, or greater values. For inexpensive grow lights (less than \$500), this 1,000W value will never reflect the consumed watts (draw power) but rather the total wattage of the chips/diodes used in the light.

Diodes come in various sizes; 1W, 1.5W, 3W, 5W, 10W, 15W, etc., and some brands like to count the total number of diodes and multiply that by the diode wattage. For example, 100 diodes at 15W would be presented as a "1,500W light." The truth is that the smaller the diode, the more efficient it is. This is important to keep in mind and this claim can also be verified in plenty of other places online.

The 1,000W+ claims made by some brands either refer to which HID/HPS lamps their LED light could replace, which is highly inaccurate as there really is no reliable way of comparing HID/HPS to LEDs out there other than light coverage and intensity.

Or, they refer to the total wattage of the fitted diodes. For example, 100 diodes at 10W each equals 1,000W. The problem with this is that a high diode wattage doesn't speak about the lamp's performance.

Theoretically, a 10W or 15W diode could produce more light than a 3W but looking at the draw power for these "1,000W" and "1,500W" lights, we see that they consume about 150-200W. This means they are running at around 15 per cent of max capacity (150W draw power/1,000W total LED wattage = 0.15 = 15 per cent). Smaller diodes, with good heat disposition, can run at 50-60 per cent capacity.

A 10W diode at 18 per cent capacity will draw 1.8W (10W*0.18 = 1.8W). A 3W diode at 60 per cent capacity will also draw 1.8W (3W*0.6 = 1.8W), meaning the total light output of these two diodes will be roughly the same. But it's obviously much less sexy to write "300W LED grow light" than "1,000W LED grow light," so some brands opt for large diodes.

The bottom line? Less heat (lower operating temperature) equals longer lifespan.

Understand Your Needs

Budget

This is straightforward. How much money do you want to spend — or can afford to spend — on a light? You typically need to spend about \$100 for a grow light that produces enough light for one to two plants, and around \$150-\$200 for a light that covers two to four plants. A rule of thumb is this: Higher grow light price = more light = better coverage = more plants = bigger harvest.

Pretty logical, right? A small and cheap (less than \$50) grow light simply can't be fitted with enough light emitting diodes to make any significant light impact on large plants such as cannabis. They may work well for smaller plants like herbs, spices, and some veggies, but large plants will need a lot of light to bear fruit/buds.

Grow Area (Light Footprint)

How many plants do you intend to grow? How big are they expected to grow? How large of an area does your light need to cover?

As light (and water and nutrients) is your plants' "food," if they receive less than required, the plants will not grow to their full potential.

Not every square inch of the plant needs maximum possible light coverage for the plant to thrive, but the majority (the more the better) of the plant should be well illuminated. You can train the plant to grow a certain way and have a certain size or area.

Beginners that are still learning plant management will likely have smaller plants, around one to two square feet per plant, than experienced growers.

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a grow light that produces enough light for one to two plants, and around \$150-\$200 for a light that covers two to four plants."

Find a grow light or a number of grow lights that cover the area of your grow. Sometimes, it makes more sense to buy two (cheap) lights rather than one expensive one.

The area a light illuminates should be specified by the grow light manufacturer. If this info is not available, it suggests the seller is either withholding information or doesn't really know how to best use the light.

Light Output and Intensity (PPFD/PAR)

Your plants need a certain amount of light to grow. To keep this guide short and on point, tomato plants, for example, will need around 300 PPFD (sometimes also referred to as PAR) when they are small and in their vegetative stage, then about double (600 PPFD) during flowering. With added CO₂ and the right ratio of nutrients, temperature, and humidity, tomato plants can take even a bit higher PPFD levels but 600 is still a good general rule of thumb.

PPFD basically means photon density; how much light hits a certain area every second. So, high PPFD means high light intensity.

Light Colour Spectrum

Plants need a full spectrum of both blue, green, and red light, similar to the sun.

Light is fundamentally photons, or light particles with a certain wavelength (colour). Light colour is measured in wavelengths by nanometer (nm). Blue light has the shortest wavelength of around 400-475 nm, then green (475-550 nm), yellow/orange (550-625 nm) and red (625-700 nm).

Various research says an ideal colour spectrum for plants consists of 15-20 per cent blue light, 15-25 per cent green light, and about 60 per cent red. This balance is optimal for plant growth, health, and photosynthesis. The natural sun colour spectrum has more green and yellow, and less blue and red, but plants thrive when boosting blue and red a bit.

Practically every brand and every grow light out there has a different spectrum (different ratios between blue, green, and red). Most of them claim they have the "perfect full spectrum light" when the reality is different. Some brands even make this claim when they barely have any green light at all coming out of their grow light.

In short; look for a colour spectrum that has a decent amount of blue and green but a lot of red, as it's the red light that the plant craves the most.

Lamp Efficiency and Watts (efficacy in umol/J or PPF/W or PPE)

You want a grow light that is efficient, or high efficacy measured in umol/J (or PPF/W or PPE, same thing, different names). An efficient light will be able to put out more photons per consumed electricity. Typically, grow lights in the cheaper price range (\$100-200) will consume anywhere from 50W to 150W. This should be specified by the manufacturer.

More consumed watts somewhat correlates to more light output, but there are two important additional factors to add into the mix:

Efficacy

Efficacy refers to the grow light's efficiency in turning electricity into light. High-efficacy, measured in umol/J or PPF/W means the lamp is better at converting electricity to light.

Example: Grow light A consumes 100W and has a 1.0 umol/J rating. Grow light B consumes 100W but has 1.5 umol/J rating.

This means grow light B is 50 per cent more efficient at turning electricity into light and effectively will emit 50 per cent more light per consumed watt.

Generally speaking, budget lights will perform at around 0.8 to 1.5 umol/J. High-end lights (usually more than \$500) can reach efficiency ratings that are twice as high.

Spectrum

The previous example is correct in assuming both grow lights have the same colour spectrum, or both grow lights emit light of the same colour. If you take a quick look among grow lights, you will see that some lamps emit a light that is very blue, red, or purple-coloured, whereas your typical desk lamp or ceiling lamp emits a white/yellowish light, right?

Certain light colours, primarily blue and red, are easier to produce. Green, UV, and far red, for instance, require much more electricity to produce.

Therefore, many grow light manufacturers opt to have a colour spectrum of primarily or even exclusively blue and red light. While this will produce the maximum amount of light output, this spectrum is very imbalanced and not ideal for plants or for your eyes. It's an unnatural light and irritating to look at for long periods of time. A light colour spectrum close to natural sunlight, or at least pinkish (less heavy on blue and red) is the ideal choice for both plants and humans.

So, to determine the lamp efficiency of a grow lamp, compare the spectrum (make sure it's well balanced) and efficacy (umol/J, PPF/W, or PPE). You want a fair spectrum and high efficacy. Then look at how much electricity (watts) the lamp draws, how much light it puts out (PPFD), and how large an area it illuminates. Some lamps will have a high light output, but they focus the light into a very small area. This is good if you only grow one plant but not ideal if you have a larger area to cover.

Generally speaking, budget lights

will perform at around 0.8 to 1.5 umol/J. High-end lights (usually more than \$500) can reach efficiency ratings that are twice as high."

The Bottom Line on Buying LED Grow Lights

Think critically and don't take any claims made online as facts unless you can verify them. Sometimes an email to the manufacturer asking how they did their test and asking them to provide any kind of evidence is enough. The best way is obviously to see indisputable evidence in the form of video test reports that cannot be faked or modified.

Also, try to look up the same model in various places as I've seen highly inaccurate or variable information depending on the site/source.

Understanding the basics of how lights work and knowing what numbers to look for is necessary for you to make a smart purchase decision.⁽¹⁾



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WATER-SOLUBLE CANNABINOIDS A happy byproduct

Research scientists at Trait Biosciences were looking for ways to improve cannabis and hemp yields when they discovered a method to make water-soluble cannabinoids. For an industry on the verge of an edibles revolution, it's an important discovery at the perfect time.

by Lee Allen

hile searching for new ways to increase yield, a research laboratory in New Mexico that focuses on hemp and cannabis came up with what they called "a happy byproduct" — water-soluble cannabinoids for food, beverages, and nutraceuticals that can be produced at commercial scale.

The company, Trait Biosciences in Los Alamos, New Mexico, had nearly 50 research scientists working for two years to make good cannabis even better when they came up with the unexpected — a clear liquid (or powder) that can instantly dissolve in water for cannabinoid-infused beverages, edibles, nutraceuticals, and other products.

It's the first successful stable genetic transformation of the cannabis sativa (hemp) plant and the first time a hemp plant has been stably transformed and successfully grown from roots and stems that will pave the way for commercialisation. It's also an important advance for the cannabis industry as Canada gets ready to legalise edibles and concentrates federally and demand for these products in the US continues to grow.

"Trait Distilled can be used everywhere," says Ronan Levy, Trait's chief strategy officer. "The biggest focus has been on cannabis beverages and edibles, but pharmaceutical and wellness products fit in here... anything that has higher bioavailability, but no taste profile." Here's the roadmap. Dr. Richard Sayre, Trait's chief science officer, was chasing ways to increase cannabinoid yield in cannabis and hemp when two paths converged. "One of the reasons for limited plant yield is that cannabinoids, in a sense, are toxic to the plant, so it only produces them on the bud surface before exporting them to the trichomes for storage," says Levy.

Then the light went on. "Dr. Sayre understood that the natural process of glycosylation that detoxifies things could also be used to detoxify cannabinoid creation in plants and thereby significantly increase yield in hemp and cannabis."



Trait researchers went to work on creating plants that produced glycosylated cannabinoids naturally and throughout the plant. The company spent 18 months refining the process of taking conventional extracts from natural plants, then utilising their cells to do the actual glycosylation process after traditional extraction.

"You attach a sugar molecule to cannabinoids and convert them to water-soluble," says Levy, making the process sound simple. "Previous fat-soluble cannabinoids didn't mix well in water for beverages and edibles — witness your salad dressings — but when you glycosylinate it, it mixes perfectly into a beverage that is tasteless, colourless, odourless, and shelf-stable, and you can't say that about cannabinoids, generally speaking."

He adds that from Trait's perspective, it's important to bring high science to impact the growth of the cannabis industry to ensure potential therapeutic and health benefits in cannabinoids are made available to a larger market. One of the main concerns dealt with negative associations involving nanotechnology where nanoemulsions or nanoencapsulation were being used to coat cannabinoids to get around the separation issue. In addition to the ability of being able to produce water-soluble cannabinoids with far greater bioavailability and onset time compared to fat-soluble cannabinoids, plants grown by the company are also expected to generate cannabinoid yields two to 10 times higher than conventional plants.

"In the future, we'll continue to engage the biggest challenge facing the industry and that is producing enough cannabinoids to supply the industry," says Levy. "And going forward, we'll be working on production of minor cannabinoids at scale so they can be used in formulations for pharmaceutical products. While everyone talks about THC and CBD, there are well over 100 identified cannabinoids and each may have its own therapeutic application as a water-soluble product easier to formulate into pharmaceutical products."

Because Trait Biosciences is a research and development company that comes up with the new ideas, "When it comes to producing Trait Distilled at scale, we will be partnering with an organisation that can do fermentation at mass scale instead of us trying to do it in-house," says Levy.

Expectations are that Trait Distilled products will be on the market by fourth quarter 2019. ⁽¹⁾



"In the future,

we'll continue to engage the biggest challenge facing the industry and that is producing enough cannabinoids to supply the industry."

Ronan Levy

"But nanoparticles are so small, they actually create a whole bunch of potential health risks by interfering with your DNA, crossing the blood-brain barrier, causing immune system responses, and accumulating in your body," says Levy. "Because of the risks, a lot of food companies are moving away from the use of nanoparticles in their product because it creates liability for them. When you're looking at people using CBD for wellness or THC for recreation, ingesting nanotechnology means taking unnecessary risks with your health. That's why our Trait Distilled process is so exciting. Instead of using nanotechnology, we're using a natural process your body does anyway with cannabinoids."

In late June, Trait received patent protection over all key technological components for the company's Distilled and Amplified technologies from the US Patents and Trademarks Office.

Asked if this development was kind of like a kick in the seat of the pants for the industry at large, Levy says he thinks so. "Absolutely. We're setting the standard in terms of both innovation and prudent science, doing incredible stuff and building a Center of Research Excellence for cannabis, hemp, and cannabinoids. All our technology gets put through rigorous trials and we know it's perfectly safe with no long-term harmful effects before any human ingests it."

HUMIC AND FULVIC ACID

SECRET WEAPONS FOR YOUR GARDEN

Turns out two of the most essential amendments gardeners can have in their growth arsenal are humic and fulvic acids. Read on to see the numerous ways these nutrients can help with your plants and crops.

by Chris Bond
H umic and fulvic acids are two of the hardest working and most versatile amendments you can give your crops. They are both naturally formed by the microbial action and degradation of carbon-based materials in soils. All healthy soils have some amount of these important acids that are most commonly found in the layer of organic material or humus. Their importance to soil fertility, root growth, nutrient uptake, and increased yield has been known and studied for almost 200 years, though most useful results for the home grower have emerged in the last few decades.

Humic Acids*

Humic acids (HA), the primary humic substance, are a hydrophobic compound. They are soluble in high pH environments (alkaline), but stable in neutral and acidic environments. In nature they are found in all soil types. In clay soils, they help to break up compacted soil masses; in sandy soils, they help to retain moisture by decreasing the rate of evaporation. The structure of HA varies greatly depending on where they are found. In various forms, they can assist in increasing the rates of seed germination, help to increase and even kick start the development of microbial and microfloral communities in soils.

*All of these results (and many more) can be found in the fall 2015 issue of Scientiae Horticulturae by authors L.P. Canellas, et al.

Fulvic Acids

One of the key differences between the two acids is fulvic acids (FA) are soluble at all pH levels, not just alkaline conditions. This means they are essentially useful and useable to plants regardless of soil condition or media type. Other important distinctions include FA's double oxygen content and exchange capacity as compared to humic acids.

Compared to clusters of HA, fulvic clusters are significantly smaller. This allows for ready entry into stomata and openings in the stems, branches, shoots, and roots of plants. This is an important trait of FA as they are able



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"HUMIC AND FULVIC ACIDS ARE ALSO WIDELY USED TO INCREASE THE HEALTH AND SIZE OF ROOTS, SHOOTS, STEMS, LEAVES, AND FRUITS OF

MOST CROP TYPES."





to collect minerals and elements on the plant surface and carry them into plant tissue and cells. This is especially true when FA are applied as part of a foliar application.

Combined Benefits of HA and FA

Both HA and FA can be found in many commercially available fertilisers and amendments. They can be thought of as "helpers" as they enhance a plant's ability to effectively utilise nutrients and trace elements. Studies have shown the delivery of the macronutrients nitrogen, phosphorus, and potassium is often at least 100 per cent, and as much as 500 per cent more effective when coupled with an appropriate amount of HA or FA. Humic and fulvic acids are also widely used to increase the health and size of roots, shoots, stems, leaves, and fruits of most crop types. Additionally, they are known or thought to:

- Aid in the transport of various nutrients by moving minerals throughout cell membranes.
- 2. Accelerate plant metabolism. Effects have been noted as soon as eight hours after application.
- 3. Increased carbohydrate production. This is evident starting between 24 to 48 hours after application and can be directly attributed to higher quality and increased yields.
- 4. Enhance the chlorophyll content of plant leaves. This corresponds with an increase in the uptake of oxygen in the plant.
- 5. Help regulate plant growth hormones.

When and How to Apply Humic and Fulvic Acids

Plants at any stage of development can benefit from appropriate dosing of HA or FA. Younger plants and seedlings tend to reap a higher benefit from humic substances, but any actively growing plant or plant tissue will favourably respond to either HA or FA. Younger plants and younger foliage on older plants which are more actively metabolising make more efficient use of humic substances. In any instance, they are not needed in large quantities to be beneficial.

In concentrated forms, not much HA is needed to be effective. No more than 0.01-0.02 ounces per gallon is needed (about 100 mg per litre of water). Too much HA can inhibit or slow down root, shoot, branch, and leaf growth. This is primarily relevant for foliar applications. When applications of humic substances are made to the soil. the concentration can be higher as a substantial amount will remain in the soil and only one quarter to one third may be absorbed and translocated throughout the plant. Foliar applications can be best utilised if mixed with other trace minerals needed and timed to correspond with the needs of the plant in its respective stage of development. These would correspond for the most part with the onset of vegetative growth, development of flowers, setting of seeds or fruits, and subsequent ripening.

Results of HAs and FAs on Various Crops

Countless studies have been done to evaluate the benefits of numerous types of humates and humic substances in various doses on hundreds of different crops. Individual results can be found throughout scientific journals, but as examples of the effectiveness of humic and fulvic acids, check out just a few published results*:

Fruits and...

- Apricots sprayed with various doses of commercially available HA showed increased yields between 16 and 33 per cent based on dosage.
- 2. Peaches given foliar applications and/or soil applications of commercially available HA showed increased fruit yields up to 80 per cent.
- 3. Hydroponically grown strawberries given HA showed yield increases up to 33 per cent as well as improved fruit firmness.
- 4. Passion fruit sprayed with varying doses of HA at various times during development displayed a 124 per cent increase in dry root mass, suggesting that the HA caused significant increases in root development.

Vegetables and...

- 1.Seeds of beans were treated with HA; higher germination rates, faster growth, and higher yields were all noted.
- 2. Cucumbers given FA showed increased growth, higher nutrient uptake, and increased flowering.
- 3.Tomatoes treated with both HA and FA showed increased dry mass weight, increased fruit yield, and decreased rates of Phytophthora.

Allium and...

- 1. Garlic sprayed with humic acid showed a two to six per cent increase in size and a longer storage life.
- 2. Onions sprayed with a blend of humic acid increased yield by five to six per cent as well as an increased marketability (uniform size and appearance) of 26 per cent.

Flowers and...

- 1.Chrysanthemums given various doses of HA responded proportionately with increased stem and root dry weights. Flower diametres were increased up to 33 per cent with HA treatments.
- 2. Gladiola corms were soaked in humic acid for 24 hours prior to planting; increased growth and early flower maturity corresponded.

*From the fall 2015 issue of Scientiae Horticulturae by authors L.P. Canellas, et al.

There can be little doubt that humic and fulvic acids can provide increased yields in a wide range of crops. Like any substance, of course, follow on-label dosing instructions and perform an analysis of your growing media before using any amendment liberally. 🚳



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CIRCUTOR

by Shannon McKee

Your crop and fish may be getting by, but are they thriving? If not, you may want to ensure your system is circulating well and dissolved oxygen levels are ideal. Shannon McKee explains what to look for. There are a lot of different things you can measure in your aquaponics system. The conditions and quality of the water in the system will determine the quality of the crops you're growing and the health of the fish. If one little thing goes out of whack, your system could be in big trouble to the point where you may have a devastating event on your fish and crops. You've probably tested the temperature, pH, ammonia levels, and other factors in your system. However, have you tested to see if your circulation system is running correctly? The oxygen level in your aquaponics system is probably one of the most important things you should be checking. Poor circulation in your systems means there won't be adequate levels of dissolved oxygen in the water for the fish and plants.

SIGNS YOU NEED TO CHECK YOUR DISSOLVED OXYGEN LEVELS

The best way to identify how well your circulation system is working is through testing the dissolved oxygen in your system, but there are other clues that can tell you there's a problem with the amount of oxygen you have. Your fish are the perfect canary in your aquaponic setup, and you'll probably notice the signs that the fish give off about the oxygen levels before you notice issues with your crops.

Just like a miner's canary, the fish can give you clues about the environment you're growing in. Here's what to look for in your fish that could signal a problem with your oxygen levels:

- Poor appetite where they aren't eating as much as they did previously.
- Your fish don't seem to be getting any bigger as their growth has stopped or slowed.
- You're dealing with more disease or parasites as your fish can be more susceptible in lower oxygenated water.
- You may also notice your fish are all swimming right around the inflow pipe trying to get more oxygen in their system.
- Your fish are gasping at the surface trying to take in more oxygen. This sign is a red alert that your circulation system isn't providing enough oxygen for your fish and you need to do something fast before you lose them.

When you notice these signals, you're going to want to start testing your system for problems, with the first tests focusing on the oxygen levels. It's possible your fish may have been harmed from the period of reduced oxygen, so even after you get this addressed, you will need to continue monitoring them.

There are also some signs your plants' roots aren't getting enough oxygen as well. These include root rot where roots are dying off; plant growth can be hindered from a lack of the correct nutrients making it to the plant, and a lack of calcium can occur. Keep in mind that when your plants start to flower and bloom, they need even more dissolved oxygen.

TESTING THE DISSOLVED OXYGEN

There are two ways you can test your oxygen levels, and each have their own pros and cons.

The first is using a test kit that can help you determine an imprecise, but still helpful number that gives you an idea of the level of your oxygen. This testing kit can be timeconsuming to use, but it's an inexpensive way to check your circulation system.

The other option you have is to invest in a dissolved oxygen meter, also known as a DO meter. This tool is a bit more expensive than the test kits but gives you faster and more precise results when it comes to your oxygen levels.



"WHEN IT COMES TO YOUR AQUAPONIC SYSTEM, IT'S VITAL TO ENSURE YOUR CIRCULATION IS ADEQUATE TO KEEP BOTH YOUR FISH AND YOUR PLANTS HAPPY AND HEALTHY."

DISSOLVED OXYGEN LEVELS

The exact amount of dissolved oxygen you want in your aquaponic system will depend on what fish and the plants you are farming. Some species of fish, such as the black bullhead, and plants, such as taro or lettuce, don't require high levels of dissolved oxygen and can be happy in about 3 mg/litre.

However, most of the fish you farm will need at least 4-5 mg/litre with some requiring as high as 8 mg/litre. Trout and salmon are both at the higher end of the scale. Also remember that even though your fish can survive at a lower level, they may not be thriving. If you want them to grow and to breed, a higher oxygen level in your aquaponics system is crucial. Some people believe you can add as much oxygen as you like as long as your fish aren't being blown out of the water by the amount of aeration added.

SOLUTIONS

There are a few solutions to circulation system issues in your aquaponics system after you've checked it for any issues. Problems with your equipment, such as breaks or build-up may mean items need to be repaired or replaced. Once you handle this maintenance, it can be a good idea to check your dissolved oxygen levels again.

Another solution is to add another aeration device in addition to moving some of the water that comes from flooding, and draining your grow beds to the fish tank. You can also make a water feature with a dynamic water flow. This addition is helpful as the cascading water going back into the system will add oxygen to the water. Remember that heat can reduce the amount of oxygen in the water, so increase your aeration efforts during the hottest months or find ways to cool the water. In addition, you want to make sure you're not overstocking fish in your system.

A final way to keep your circulation system running smoothly is to ensure you have backup power in case of an outage. A battery backup to your pumps will help to save your fish during the next blackout.

Keeping an eye on your oxygen is just as important as the temperature, nutrient solution, pH, and other factors you test. When it comes to your aquaponic system, it's vital to ensure your circulation is adequate to keep both your fish and your plants happy and healthy. The key to checking the circulation is testing the dissolved oxygen that's in the water located in different points in your system and, if something is wrong, adapting the system to fix circulation problems will keep your fish thriving. **(**)

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BACILLUS THURINGIENSIS IN HORTICULTURE

One of the best natural pesticides a grower can use against pest insects is a naturally occurring bacteria called *bacillus thuringiensis* (Bt). Eric Hopper explains why Bt is so effective.

by Eric Hopper

P est insects can wreak havoc on an otherwise healthy vegetable garden. Unlike gardeners who specialise in ornamental crops, those who grow vegetables or other plants for human consumption must be careful with the products and methods used to treat pest insects. Many chemical pesticides and herbicides can leave behind residuals that can be unhealthy to humans or other mammals when consumed. Although they are not always 100 per cent safe, natural- and organic-based pesticides

tend to be safer options for vegetable crops. Some of the most commonly used and effective types of insecticides for protecting vegetable crops are derived from a naturally occurring bacteria called *bacillus* thuringiensis (often abbreviated to Bt).

There are many recognised subspecies of Bt; however, bacillus thuringiensis kurstaki (Btk) and bacillus thuringiensis israelensis (Bti) are the two particular strains of Bt that are most commonly used in horticulture. Each of these Bt subspecies offers protection against particular types of pest insects.

"BT PRODUCTS ARE ONLY EFFECTIVE WHEN INGESTED BY THE DECT INCECT "

Top right: German microbiologist Ernst Berliner rediscovered Bt as the culprit responsible for killing a Mediterranean flour moth.

Bottom right: Avoid applying Bt products right before it rains and target times when pests are most actively feeding.



History of *Bacillus Thuringiensis* (Bt)

Bacillus thuringiensis (Bt) was first discovered by Japanese biologist Shigetan Ishiwatar when he was trying to find the cause of the sudden collapse disease that was killing large populations of silkworms. He successfully isolated the bacterium Bt and identified it as the cause of the disease in 1901. In 1911, a German microbiologist, Ernst Berliner, rediscovered Bt as the culprit responsible for killing a Mediterranean flour moth. The bacterium was named bacillus thuringiensis after the German town, Thuringia, where the moth was found. Through his research, Berliner reported the existence of a crystal toxin within Bt. However, the specifics of how this crystal worked was not realised until much later. Due to Berliner's work. farmers started to use Bt as an effective pesticide in 1920. There was even a commercialised sporebased formulation sold under the name Sporine during the 1930s. At the time, Sporine was primarily sold and used to kill flour moths.

In 1956, a group of researchers found that the main insecticidal activity found in Bt could be attributed to its parasporal crystal body. A parasporal body is a crystalline protein that forms around a spore in some bacteria and can act as a toxin precursor when ingested by particular insects. The discovery of the parasporal crystal body inspired more research and interest in the crystal structure, biochemistry, and mode of action of Bt. In other words, many scientists jumped on board to learn more about Bt. This led to Bt being used commercially in the US in 1958 and, in 1961, Bt was officially registered as a pesticide by the Environmental Protection Agency (EPA). Up until the late 1970s, all the discovered subspecies of Bt were used to treat lepidopteran (the order of insects that

includes butterflies and moths) larvae. In 1977, a subspecies of Bt was discovered that was toxic to dipteran (the order of insects that includes flies, mosquitoes, and fungus gnats) species. In 1983, another subspecies was discovered that was toxic to coleopteran (beetles). The popularity of Bt as an insecticide expanded significantly throughout the 1980s because pest insects were becoming increasingly resistant to synthetic insecticides. It was also during this time

that scientists and environmentalists became aware of the negative effects chemical insecticides have on the environment. Agriculturists and gardeners who were concerned with these negative effects turned to Bt as a safer and effective alternative.



Bacillus

Thuringiensis Kurstaki

Bacillus thuringiensis kurstaki is one of the commonly used Bt subspecies to treat lepidopterans on consumable crops. Some of the most common pest insects that can be treated with Btk are cabbage loopers, gypsy moths, tent caterpillars, and tomato hornworms. During its sporulation, Btk forms crystal proteins that are deadly to lepidopteran larvae. For Btk to be effective, it must be ingested by the pest insect. Put another way, Btk must be applied directly to the foliage where the pest insect feeds. Once ingested, Btk breaks down the pest insect's gut from the inside, thus killing it. Bacillus thuringiensis products are favoured by many horticulturists because of their ability to target specific pests, while having little or no effect on other insects that do not feed on the foliage. so Bt products won't harm beneficial insects, unlike many chemical pesticides. This allows horticulturists to employ beneficial predatory insects, in conjunction with Bt, as a treatment against pest insects.

Bacillus Thuringiensis Ilsraelensis

Bacillus thuringiensis israelensis is a Bt subspecies commonly used in horticulture to treat fungus gnat infestations. Bacillus thuringiensis israelensis is also effective at killing mosquitoes and black flies. The biggest advantage of Bti, like other Bt subspecies, is its ability to effectively kill targeted species, while having almost no effect on other organisms.







Bacillus thuringiensis israelensis contains Cry and Cyt proteins that are pore-forming toxins that break down the cells of the midgut (part of the insect's digestive tract) by inserting into the cell membrane and forming pores. In layman's terms, Bti creates holes in the digestive system of the targeted pest insect and kills them from the inside out.

Application Instructions for Bt

Although horticulturists should follow the specific application instructions provided by the manufacturer of a Bt insecticide, there are a couple of general rules of thumb that will make Bt applications more effective against pest insects. First, Bt products are only effective when ingested by the pest insect. Spray irrigation or rain will wash the Bt from the foliage, making it ineffective against the pest insects. Therefore, horticulturists should avoid applying Bt products right before watering or scheduled rain. Second, depending on the particular pest insect being targeted, horticulturists should try to apply Bt products when the pests are most actively feeding. For example, cabbage loopers are most active on hot, dry days. Applying Bt on the days when the atmospheric conditions make pests most active will make the treatment more effective.

Genetically Modified Crops Using Bt Genes

Due to advancements in molecular biology, scientists are able to move the Bt gene that encodes the toxic crystals into a plant. The first Bt-based genetically engineered plant (Bt corn) was registered with the EPA in 1995. Commonly referred to as Bt crops, today there are multiple crops that have been modified with genes from Bt, including cotton and potatoes. When pest insects feed on these genetically modified crops, the toxic crystals are ingested by the pest insect and break down the insect's digestive tract, resulting in death.

Concerns Regarding Bt

Although Bt pesticides are one of the safest pest insect treatment options, overuse of Bt products could pose problems. Some studies have shown that, although Bt is non-toxic to non-targeted organisms, the accumulation of Bt toxins in the soil might lead to Bt resistant insects. Put another way, it is possible targeted pest insects could build up a resistance to Bt if overused. The same holds true for genetically modified Bt crops as well. Overuse of Bt crops could lead to pest insects with a heightened resistance to the effects of Bt.

Regardless of whether a horticulturist chooses chemical or organic pesticides to treat a pest insect problem, he or she should always follow the manufacturer's suggested handling and application instructions. Also, a grower is responsible for researching the possible negative effects of any pest insect treatment before applying it in the garden. For vegetables or other crops that will eventually be consumed, organic pesticides tend to be a safer option. Generally speaking, certified organic pesticides break down more quickly than their chemical counterparts and will not leave behind harmful residuals. Most Bt-based pesticides are allowed in

organic farming practices because Bt is a naturally occurring, non-pathogenic bacterium found in soil. Bacillus thuringiensis specifically affects the digestive system of pest insects that feed on treated foliage and does not persist in the digestive systems of mammals. In fact, the EPA has not found any human health hazards related to Bt pesticides.

Overall, Bt is one of the safest insecticidal options for horticulturists due to its ability to specifically target pest insects, without affecting innocent bystanders. Gardeners who are especially concerned about protecting their crops, while also protecting themselves, can responsibly use Bt-based insecticides for both safe and effective results.



Top left: Gypsy moth butterflies can be treated with Btk.

Top right: Btk must be applied directly to the foliage where the pest insect feeds.

Above: Fungus gnat infestations are commonly treated using Bti.

"BTI CREATES HOLES IN THE DIGESTIVE SYSTEM OF THE TARGETED PEST INSECT AND KILLS THEM FROM THE

INSIDE OUT."

wherever you are, whatever you're doing,

we'll come

you.

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Empowering the Future of SCIENTIFIC RESEARCH.



Across International is the leading manufacturer of heat treatment and material processing

equipment. With more than 20 years of manufacturing experience, Across International enables scientists to make the world a better place by providing innovative products to further their research and solve complicated challenges. Anna Tykowski provides some insight into the team at Across International and their approach to succeeding in a challenging industry while having a good time together.

- acrossinternational.com
- 1-888-988-0899
- 111 Dorsa Avenue, Livingston, NJ 07039
- Number of years doing business: 20+
- Company motto: "Empowering the future of scientific research."

What did Across International's founder, Sam Huang, do before starting the company?

Sam Huang was in the medical field before starting Across International. He was a data integration specialist at a hospital. It was there that he fell in love with laboratory equipment. Soon, he had the idea that he could improve on the designs he had seen, and the seeds of our company were born.

How did Across International get into the cannabis industry? In our earlier years, we noticed many orders for vacuum ovens and pumps were being shipped to residential areas. After doing some research, we learned that the cannabis industry had taken an interest in our equipment. Customers were primarily using the ovens and pumps to make extracts such as BHO for patients. We began learning more about the industry and have dedicated ourselves to helping our customers produce clean end products in ways that prioritise user safety and processing efficiency.

When and where did Across International begin?

Our company was founded and is headquartered in New Jersey. We have more than 20 years of industrial manufacturing experience.

What were the start-up years like?

Our early years consisted of long nights and hard work, but it was worth it to be where we are now. We learned a lot about the cannabis industry by working with leading experts in the field.

How many people were employed by the company at the beginning? What were their roles?

We started out with five extremely hard-working staff members. Our office and warehouse were on the smaller side, and we soon found that we had outgrown our building. We moved our headquarters to Livingston, New Jersey, in 2013. Even in our early days, customer care was an extremely important part of our business model. We have always sought to meet and exceed our customers' expectations from day one.

What did AI first produce?

Laboratory R&D equipment: furnaces, vacuum ovens, forced air ovens, ball mills, pellet presses, glove boxes, induction heaters, and vacuum pumps. We also sold (and continue to sell) consumable parts for the equipment.

What were some of the struggles as AI got started? How did you overcome them?

One of our biggest struggles was being able to service our customers on the west coast quickly and efficiently. We knew our customers needed their equipment to arrive as soon as possible. Time was of the essence. It was also critical for us to be able to provide support hours which complimented the three-hour time zone difference.



"We've won numerous awards

FOR OUR INNOVATIVE EQUIPMENT, AND WE PRIORITISE OUTSTANDING CUSTOMER SERVICE, PROMPT RESPONSE RATES, AND FAST SHIPPING." Opening our second location in Nevada greatly improved our ability to meet these goals and improve our overall customer experience. Many states now experience delivery up to 85 per cent faster than before. It's all about making sure that our customers know they can be taken care of at a moment's notice. We're proud of doing exactly that.

How did you gain market share and recognition?

Product R&D is at the heart of our business. We actively listen to feedback from our customers and consider their needs when we are developing our catalogue. We've won numerous awards for our innovative equipment, and we prioritise outstanding customer service, prompt response rates, and fast shipping. We stand behind the quality of our equipment with our manufacturer's warranties and a 30-day guarantee. Even after the warranty, we continue to offer free lifelong phone and email service and support for any machine we've manufactured. We also actively engage with our customers on social media. Customers can comment on our posts or direct message us, and we'll gladly respond to any inquiries.

Has Across International moved or expanded since the beginning?

We opened our second location in Sparks, Nevada, in 2015 to provide better, faster service to the west coast. Our third location in Victoria, Australia, opened in 2016.

What is your current product line?

Specific to cannabis: rotary evaporators, short path distillation, vacuum ovens, forced air ovens, cold traps, chillers, vacuum pumps, freezers, jacketed reactors, homogenisers, and presses. Other scientific equipment includes furnaces, ball mills, pellet presses, and induction heaters. A comprehensive list of items can be viewed on our website.

Where do you distribute?

Our brand can be found in laboratories worldwide. We have distributors throughout the US, Canada, Spain, Australia, and many other countries. We also have the ability to ship to any location in the world.

How many people now work for the company?

Many long nights and years of hard work have allowed us to expand and employ over 50 staff members throughout Nevada, New Jersey, and Australia.

What are Across International's strengths?

Our product reliability. We manufacture, quality control test, and warranty high-quality products that dispensaries can trust to reliably produce the same results, time after time. Dispensaries cannot afford downtime or unwanted variables. They need machines that can run predictably and without interruption. We make sure that our equipment can do that for them, and that is a great feeling!

What are some of your proudest moments?

We're very proud of the awards our equipment has won. Our vacuum ovens won the *High Times* S.T.A.S.H. (Significant Technological Achievements in Secretive Horticulture) award three times consecutively. We have also received the ExpoGrow award for Best Paraphernalia Equipment.

What significant things have you learned so far about the industry?

Product efficiency, quality, and safety play key roles in developing the best extraction technology on the market. We've made it our priority to include safety options such as UL/CSA certification on our equipment. We have increased the efficiency of our 20L and 50L rotary evaporators by outfitting them with dual receiving flask holders (optional) to eliminate downtime. Our quality is supported by our product warranties and outstanding customer service and support.

What have you learned about starting and growing a company?

Customer service is vital to success. For a company to survive, it must stand behind the quality of its products and embrace industry changes as they occur. We offer the most convenient purchasing experience to customers and continue to advance our product technology to further accelerate research and discovery. We endeavour to build long lasting business partnerships around the world. Providing excellent customer service and support is always our top priority.

What words of wisdom can you share about the business, the industry, or the future of the industry?

Change is not something to be feared. It is an opportunity waiting to be met with determination. Embrace industry changes and look for ways to help clients adapt to these changes with you.

Share your favourite story from a day on the job.

It was May 2016 and summer was just around the corner. One of our tech support agents had the brilliant idea of making ice cream using our T40 cold trap so we could use up a surplus of hot chocolate K-Cups left over from the winter. It was a hit, and everyone got to enjoy a cool tasty treat. It was shared to our social media and we dubbed it "The Hungry, Hungry Tech Support Agent."

What makes your employees so awesome? How does your team bond?

We have a great team of talented professionals who are passionate about the work they do. We work in a supportive environment where everyone is encouraged to share ideas and collaborate. Our team thrives in cross-functional environments and enjoys working with different departments to gain a fresh perspective.

We bond over food. We're foodies at heart, and we love to bond over our annual holiday parties, birthdays, and when we accomplish monumental goals. Across International employs a richly diverse group of talented individuals. We encourage our employees to share their favourite dishes from their culture when we have our celebrations.

Does Across International participate in any community service?

We recognise how important it is to give back to our communities and are planning to develop community service programs soon. Many of our employees volunteer outside of work for a variety of great causes and we could not be more proud of their efforts. ^①



"Change is not something to be feared... IT IS AN OPPORTUNITY WAITING TO BE MET WITH DETERMINATION."



distribution **LIST**

retail stores are listed alphabetically in each state

ACT

South Pacific Hydroponics #2 - 84 - 86 Wollongong St. Fyshwick ACT 2609 (02) 6239 2598

South Pacific Hydroponics 70 Oatley Crt. Belconnen ACT 2617 (02) 6251 0600

NEW SOUTH WALES

24/7 Hydroponics 151 Wine Country Dr. Nulkaba NSW 2325 (02) 4990 4291 admin@simplydvine.com.au

99 Trading 57 Hoskins Ave. Banks Town NSW 2200 (02) 9790 1525

Accent Hydroponics Unit 1/5 Clerke Pl. Kurnell NSW 2231 (02) 9668 9577 accenthydroponics.com

ASE Hydroponics Factory 10/45 Leighton Pl. Hornsby NSW 2077 (02) 9477 3710

Ballina Hydro 19 Cessna Cres. Ballina NSW 2478 (07) 3354 1588

Criscete Hydroponics and Organics Unit 2/15 Kam Cl. Morisset NSW 2264 (02) 4973 5779

Cougars Hydroponics 2/6 Ace. Cres Tuggerah NSW 2259 (02) 4330 0190

Dubbo Hydro & Tobacconist 42c Victoria St. Dubbo West NSW 2830 (02) 6885 1616

Earth & Colour Vertical Gardens and Hydroponic Supplies 1/43 Corporation Cir. Tweed Heads South NSW 2486 (07) 5523 9565 earthandcolour.com.au

Favgro Hydroponics Growers 107 Glenella Rd. Batehaven NSW 2536 (02) 4472 7165

Felanza - Hydroponics 140 Princess Hwy. Arncliffe NSW 2205 (02) 9556 1494

General Hydroponics 7/14 Sunnyholt Rd. Blacktown NSW 9676 (02) 9676 8682

Grow Your Own Unit 6/34 Alliance Ave. Morisset NSW 2264 (02) 4973 5179



Holistic Hydroponics Pty. Ltd. Unit 21/322 Annangrove Rd. Rouse Hill NSW 2155 (04) 8803 8807

Home Grown Aquaponics 8A-8B 13 Hartley Dr. Thornton NSW 2322 (02) 4028 6388 home-grown.net.au

Hong Hung D5 303 The Horsley Dr. Fairfield NSW 2165 (02) 8764 1083

Hyalite Kingsgrove 1/4 Wirega Ave. Kingsgrove NSW 2208 (02) 8068 5896

Maximum Yield

86

Hyalite Prestons (New South Wales) 2/4 Avalli Rd. Prestons, NSW 2170 (02) 3824 3400 Hyalite Villawood

2/21 Birmingham Ave. Villawood NSW 2163 (02) 9723 7199

Hydro Experts 34/2 Railway Parade Lidcombe NSW 2141 (02) 8041 7959 info@hydroexperts.com.au hydroexperts.com.au

Hydro Masta 100 Station Rd. Seven Hills Sydney NSW 2147 (02) 8812 2845

Hydro Place 1/68 Nelson St. Wallsend NSW 2287 (02) 4965 6595

Hydro Shop Pty Ltd Unit 1/5-7 Channel Rd. Mayfield West NSW 2304 (02) 4960 0707

Hydro Supplies 57 Flinders St. Darlinghurst NSW 2010 (02) 9326 0307

Hygrow Horticulture (Greenlite) 252 Oxford St. Bondi Junction NSW 2022 (02) 9369 3928

Indoor Sun Shop 745 Victoria Rd. Top Ryde NSW 2112 (02) 9808 6873

Indoor Sun Shop Unit 2/109 Junction Rd. Moorebank NSW 2170 (02) 9822 4700

International Fans PO Box 120 St. Mary's NSW 2760 (02) 9833 7500

Kyper's Tools and Hydroponics Stuart & Tincogan Sts. Mullumbimby NSW 2482 (02) 6684 4928

Lismore Hydro 1/106 Canway St. Lismore NSW 2480 (02) 6621 3311 Lismore Hydroponics

Rear of 28 Casino St. South Lismore NSW 2480 (02) 6621 3311 Lux Cutting Hydroponics

252 Oxford St. Bondi Junction NSW 2022 (02) 9369 3928

North Coast Hydroponics 2/5 Wallis Ave. Toormina NSW 2452 (02) 6658 7932 northcoasthydro.com.au Northern Lights Hydroponics

6/46 Through St. South Grafton NSW 2460 (04) 3110 5882

Northern Nursery Supplies Pty Ltd 14-16 Nance Rd. Kempsey NSW 2440 (02) 6563 1599

Nowra Hydro 68 Bridge Rd. Nowra NSW 2541 (02) 4423 3224

Nutriflo Hydroponic Systems 19/5 Daintree Pl. Gosford West NSW 2250 (02) 4323 1599 nutriflo.com.au Outside in Hydroponics & Organics 2/595 Main Rd. Glendale NSW 2285

(02) 4956 5676 **Parkview Plants** 250 Princess Hwy. Nowra South NSW 2541 (02) 4423 0599

Port Pumps and Irrigation 20 Uralla Rd. Pt Macquarie NSW 2444 (02) 6581 1272

Quik Grow 510a Great Western Hwy. Pendle Hill NSW 2145 (02) 9636 7023 Quick Grow 823 King Georges Rd.

S. Hurstville NSW 2221 (02) 9546 8642 Quik Grow Pty Ltd. 490 Parramatta Rd. Petersham NSW 2049

(02) 9568 2900 Richmond Hydroponics Unit 3/84 Bells Line of Rd. North Richmond NSW 2754

(02) 4571 1620 richmondhydroponics.com.au Simple Grow Hassall St. & Windem Wetherill Pk NSW 2164

(02) 9604 0469 **South Pacific Hydroponics** 84-86 Wollongong St. Fyshwick NSW 2609 (02) 6239 2598

Sydney Garden Supplies 187 Waterloo Rd. Greenacre NSW 2190 (04) 1460 9241

The Green Room Hydroponics & Organics 2/6 Davids Cl. Somersby NSW 2250 (02) 4340 0339



The Grow Shed 4/22 Alliance Ave. Morisset NSW 2264 (02) 4972 6872

The Grow Shop 5/5 Forge Dr. Coff's Harbour NSW 2450 (02) 6651 9992

The Petshop Boyz Unit 1/ 5-7 Channel Rd. Mayfield West NSW 2304 (02) 4960 0708 petshopboyz.com.au

TN Hydroponics 1/43 Chadderton St. Cabramatta NSW 2166 (02) 9724 5692

Tweed Coast Hydroponics 2/58 Machinery Dr. Tweeds Head South NSW 2486 (07) 5524 8588

Uncle Wal's Gardenland 31 Cres. Ave. Taree NSW 2430

(02) 6550 0221 VN Hydro 8 Robert St. Belmore NSW 2192

Warrawong Hydroponics Centre 240 Cowper St. Warrawong NSW 2502 (02) 4274 8001

warrawonghydro@hotmail.com Westside Lighting & Electrical (Ezi Range) PO Box 274 Mascot NSW 1400 1 800 661 475 Wollongong Hydroponic Centre 318 Crown St. Wollongong NSW 2500 (02) 4225 8773

NORTHERN TERRITORY Darwin Hydroponics

5/8 Andrews St. Berrimah NT 0828 (08) 8947-2576 Katherine Hydroponics

Centre 17 Rundle St. Katherine NT 0850 (08) 8972 1730 Top End Hydroponics 1785 Leonino Rd. Darwin River NT 0841 (08) 8988 6076

QUEENSLAND

Advanced horticultural Supplies - Gold Coast 6/68 Blanck St. Ormeau QLD 4208 0435 255 856 adhs.com.au

Advanced Horticulture Supplies - Noosaville Shop 3 11 A Venture Dr. Noosaville QLD 4566 (07) 5641 1256 adhs.com.au

Allgrow Hydro 13 - 58 Bullock Head St. Sumner Park QLD 4074 (07) 3376 7222



Aqua Gardening Unit 3, 4 Billabong St. Stafford, Brisbane QLD 4053 (07) 3354 1588



Aqua Gardening Shop 3/73 PIckering St. Enoggera QLD 4051 (07) 3354 1588

Aquatic Oasis Unit 2/33 Smith St. Capalaba QLD 4157 (07) 3245 7777

Billabong Hydroponics Lot 1 Billabong Crt. Childers QLD 4660 (07) 4126 3551

D-Bay Hydroponics Shop 5/404 Deception Bay Rd. Deception Bay QLD 4508 (07) 3204 8324 E.T. Grow Home

Unit 1/4 Windmill St. Southport QLD 4215 (07) 5591 6501

Eye Lighting Australia Pty Ltd. PO Box 306 Carole Park QLD 4300 (07) 3335 3556

Frans Hydroponics Shed 3 1191 Anzac Ave. Kallangar QLD 4503 (07) 3285 1355

Gold Coast hydroponics 42 Lawrence Dr. Nerang QLD 4211 (07) 5596 2250

Grow Hydro 22 Mining St. Bundamba QLD 4304 (07) 3816 3206

H2 Gro Pty Ltd 2 Sonia Crt. Raceview QLD 4305 (07) 3294 3253



Town & Country Hydroponics Shop 1/8585 Warrego Hwy. Withcott QLD 4352

Walsh's Seeds Garden Centre

SOUTH AUSTRALIA

Adelaide Hydro

Kings Park SA 5034 (08) 7230 5907

adelaidebydro.com.au

ADVINED GHEN SUTTRES

Profest

Advanced Garden Supplies

Amazon Aquariums & Gardening Unit 5 16 Research Rd. Pooraka SA 5095 (08) 8359 1800

Ascot Park 753 Marion Rd.

(08) 8357 4700

(08) 8322 4383

103 Tolley Rd. St Agnes SA 5097

(08) 8265 0665

Ascot Park SA 5043

Barry's Hardware

Saints & Main North Rd. Salisbury Plains SA 5109 (08) 8281 4066

Back Street Traders Unit 6/8 Lindsey Rd. Lonsdale SA 5160

Bloomin' Hydroponics

5/535 Martins Rd. Parafield Gardens SA 5107 (08) 8281 6395

Bolzon Home & Garden

Chocablock Discount

Variety Store 15-17/1220 Grand Junction Hope Valley SA 5090 (08) 8396 3133

Complete Hydroponics

D & W Dependable Hardware

1581 Main North Rd. Salisbury East SA 5109 (08) 8258 4022

Country Hydro

(08) 8287 6399

(08) 8260 3335

Festive Hydro

(08) 8523 5100

597 Tapleys Hill Rd. Fulham SA 5024 (08) 8235 2004

Future Garden Concepts North Shop 2 21-23 Kreig Rd. Evanston Park SA 5116

(08) 8523 5100

2 Kreig St. Evanston Park SA 5116

Fulham Gardener Nursery

434 Saddleback Rd. Whyalla SA 5600 (08) 8645 3105

45B Kettering Rd. Elizabeth South SA 5112

Every Thing Hydro Shop 2/494 Main North Rd. Blair Athol SA 5084

3/8 Bredbo St. Lonsdale SA 5160 (08) 8382 1191

ood Rd

Shop 3.267 Good

Tumbling Waters

Malanda QLD 4885 (07) 4096 6443

881 Ruthven St. Toowoomba QLD 4350

Hydroponics

2 Clarkes Track

(07) 4636 1077

Home Grown Hydroponics 4/9 Barnett Pl. Moledinar QLD 4214 (07) 5571 6666

Hyalite Varsity (Queensland) 1/10 John Duncan Crt. Varsity Lakes QLD 4227 (07) 5593 7535

Hydrocenter Hydroponics 46 Spencer Rd. Nerang QLD 4211 (07) 5527 4155 HydroMart Hydroponics

1/23 Victoria St. Capalaba QLD 4157 (04) 3127 8211 Hydroponic Roots & Shoots Lot 3 Herberton Rd. Atherton QLD 4883

(07) 4091 3217 **Hydroponics & Garden Supplies** 93 Cook St. Portsmith QLD 4870 (07) 4035 5422

Hydroponics Today PO Box 785 Stanthorpe QLD 4380 (07) 4683 3133

Indoor Solutions Unit 2/79 Oxford Tce. Taringa QLD 4068

J&K Hydroponics 387 Progress Rd. Wacol QLD 4076 (07) 3271 6210

KY Garden 3/31 Argyle Parade Darra Brisbane QLD 4076 (07) 3375 9098

Logan Hydroponics 13/22, Allgas St. Slacks Creek QLD 4127 (07) 3299 1397 loganhydroponics.com.au

North Queensland Hydro Supplies Shop 2B/20-22 Fleming St. Townsville QLD 4810 (07) 4728 3957

Northern Hydroponics 383 Mulgrave Rd. Cairns QLD 4870 (07) 4054 5884

NQ Hydroponics 1/31 Casey St. Aitkenvale, Townsville QLD 4810 (07) 4728 3957

Pioneer Hydroponics 194 Doyles Rd. Pleystowe QLD 4741 (07) 4959 2016

Slacks Creek Hydroponics

Simply Hydroponics Gold Coast

#13/22 Allgas St. Slacks Creek QLD 4217

7/10 Fortune St. Geebung QLD 4034 (07) 3265 3211

Sunstate Hydroponics

unstate

Sunstate Hydroponics 10/13 Kerryl St. Kunda Park QLD 4556

(07) 5445 3499

42 Lawrence Dr. Nerang QLD 4211

(07) 5596 2250

(07) 3299 1397

Futchatec Distribution 4 Symonds St. Royal Park SA 5014 (08) 8447-1122

Glandore Hydroponics 644 South Rd. Glandore SA 5037 (08) 8371 5777 www.glandorehydro.com

Greener than Green 52 - 54 Cliff Ave. Port Noarlunga South SA 51 (08) 8386 2596

Greenhouse Superstore Lonsdale 35 to 37 Aldenhoven Rd. Lonsdale SA 5160 (08) 8382 0100

Greenhouse Superstore Royal Park 4 Symonds St. Royal Park SA 5014 (08) 8447 5899

Gro Pro Hydro 3 Kelly Rd. Willaston SA 5118 (08) 8522 7761

Ground-Up Service Nursery 3 Copinger Rd. Pt. Pirie SA 5540 (08) 8264 9455

Gully Hydro 32 Famechon Cres. Modbury North SA 5092 (08) 8264 9455

Hackham Garden & Building Supplies 32 Gates Rd, Hackham SA 5163 (08) 8382 4754

Harvest Time Hydroponics Shop 3/146-148 Findon Rd. Findon SA 5023 (08) 8244 0222

Hindmarsh Hydroponics 39a Manton St. Hindmarsh SA 5095 (08) 8346 9461

Highland Grow & Flow 14/1042 Grand Junction Rd. Holden Hill SA 5088 (08) 8395 4455

Hong Kong Hydro 13 Research Rd. Pooraka SA 5095 (08) 8260 2000



Hush Hydroponic Wholesalers 25 Charlotte St. Smithfield, SA 5114 (08) 8254 1585

Hydro Heaven Kane Motors-Hunt Rd. Mount Barker SA 5251 (08) 8391 1880

Hydro Sales & Service 1 Salisbury Cres. Colonel Light SA 5041 (08) 8272 2000

Hydro Technics 321 South Rd. Croydon SA 5008 (08) 8241 5022

Hydro Technics North 22 Peachey Rd. Elizabeth West SA 5113 08 8252 7988

Hydro Warehouse 181 Seacombe Rd. South Brighton SA 5048 (08) 8377 1200

Hydro Wholesalers 181 Seacombe Rd. South Brighton SA 5048 (08) 8377 1200

Hydro World 40 Folland Ave. Northfield SA 5085 (08) 8262 8323 hydroworld.com.au

Koko's Hydro Warehouse Unit 2/2 McGowan St. Pooraka SA 5095 (08) 8260 5463 Larg's Bay Garden Supply 239 Victoria Rd. Largs Bay SA 5016

(08) 8242 3788 Martins Rd. Hydro # 5- 353 Martins Rd. Parafield Gardens SA 5107 (08) 8283 4011

Mitre 10 Dr. In 152 Hanson Rd. Mansfield Park SA 5012 (08) 8445 1813 New Age Hydroponics

135-137 Sir Donald Bradman Dr. Hilton SA 5033 (08) 8351 9100 newagehydro.com

Owen Agencies 17-19 Railway Terr. Owen SA 5460 (08) 8528 6008

Palms & Plants 175 Salisbury Hwy. Salisbury SA 5108 (08) 8285 7575 Professional Hydro

4/522 Grange Rd. Fulham Gardens SA 5024 (08) 8353 0133

Professional Hydro Shop 5/645 Lower North East Rd. Paradise SA 5075 (08) 8365 5172

Professional Hydroponics 113 Maurice Rd. Murray Bridge SA (08) 8532 3441

Rob's Garden Centre Shop 3/364 North East Rd. Windsor Gardens SA 5087 (08) 8369 2498

Seaton Hydroponics 129 Tapleys Hill Rd. Seaton SA 5023 (08) 8268 2636 Soladome Aquaculture & Hydro 44 Chapel St.

Norwood SA 5067 (08) 8362 8042 South Coast Hydroponics

6/25 Gulfview Rd. Christies Beach SA 5165 (08) 8384 2380

State Hydroponics & Homebrew Supplies 174 Semaphore Rd. Exeter SA 5019 (08) 8341 5991

Tea Tree Gully Hydro 32 Famechon Cres. Modbury North SA 5092 (08) 8264 9455

Two Wells Hardware 86 Old Port Wakefield Rd. Two Wells SA 5501 (08) 8520 2287

Urban Grow Solutions 1/111 Main Sth Rd. 0'Halloran Hill, SA 5189 (08) 8322 0040

Waterworld Home & Garden Supplies 9 Aldershot Rd. Lonsdale SA 5160 (08) 8326 2444

Warehouse of Garden 89 Helps Rd. Burton SA 5110 (08) 8280 3314 warehouseofgarden.com.au

West Garden Centre Peachey Rd. Elizabeth West SA 5113 (08) 8255 1355

TASMANIA Advanced Hydroponics 26 Mulgrave St. South Launceston TAS 7249 (03) 6344 5588

Aqua Hydroponics Rear 45 Burnett St. New Norfolk TAS 7140 (03) 6294 9233

Ezy Grow 625 East Derwent Hwy. Lindisfarne TAS 7015 (03) 6243 9490

Garden World 717 West Tamar Hwy. Legana TAS 7277 (03) 6330 1177



Green Acres Hydroponics 46-48 Bingalong Rd. Mornington TAS 7018 (03) 6245 1066 sales@greenacreshydroponics. com.au

Growers Choice 225 Main Rd. Derwent Park TAS 7009 (03) 6273 6088

Hydroponics Systems 131 Main Rd. Moonah TAS 7009 (03) 6278 3457 Hydroponic World

322 Bass Hwy. Sulphur Creek TAS 7316 (03) 6435 4411 Lifestyle Gardens

167 Gilbert St. Latrobe TAS 7307 (03) 6426 2003

Organic Garden Supplies 17 Don Rd. Devonport TAS 7310 (03) 6424 7815

Tasmanian Hydroponic Supplies 99 Lampton Ave. Derwent Park TAS 7009 (03) 6272 2202

The Hydroponic Company 69 Charles St. Moonah TAS 7009 (03) 6273 1411

The Hydroponics Company 289 Hobart Rd. Kings Medow TAS 7428 (03) 6340 2222

VICTORIA

99 Garden Services Unit 31 12-20 James Court Tottenham VIC 3012 (03) 9314 8088

AAA Lush Hydroponics 2-4 The Arcade, Junction Village Melbourne VIC 3972

Albury Hydroponics/ Cappers Hydroponics 62 Thomas Mitchell Dr. Springvale VIC 3171 (02) 6024 4029

All Seasons Hydroponics 3 Springvale Rd. Springvale VIC 3171 (03) 9540 8000



A-Grade Hydroponics 60/148 Chesterville Rd. Cheltenham VIC 3192 (03) 9555 6667

Aquamatic 299 Monbulk Rd. Monbulk VIC 3793 (03) 9756 6666 aquamatic.com.au

Banksia Greenhouse and Outdoor Garden 530 Burwood Hwy. Wantirna VIC 3152 (03) 9801 8070

Barb's Hydro and Nursery 15 Wallace Ave. Interverloch VIC 3196 (03) 5674 2584

Belgrave Hydroponics 5/ 60-68 Colby Dr. Belgrave Heights VIC 3160 (03) 9754 3712

Brew 'N' Grow 4 - 479 Nepean Hwy Edithvale VIC 3199 (03) 9783 3006

Casey Hydroponics 12 The Arcade St. Cranbourne VIC 3977 (03) 5996 3697

Casey Hydro 78 Spring Square Hallam VIC 3803

Hallam VIC 3803 (03) 9796 3776 Central Hydro Factory 3/9 Mirra Court Bundoora VIC 3083 (03) 9466 7635 centralhydroponics.com.au

Chronic Hydroponics 31 Anderson St. Templestowe VIC 3106 (03) 9646 8133 Crown Garden Supplies

8 Glencapel Crt. Hillside VIC 3037 (04) 5996 6344 Discount Hydroponics

B Princes Hwy. Doveton VIC 3177 (03) 9792 2966 Echuca Hydroponic Nursery & Supplies

23 Ogilvie Ave. Echuca VIC 3564 (03) 5480 2036

Echuca Pump Shop 128 Ogilvie Ave. Echuca VIC 3564 (03) 5480 7080

Epping Hydroponics

Epping Hydroponics 10 Dilop Dr. Epping VIC 3076 (03) 9408 4677 eppinghydroponics.com.au

Excel Distributors Pty Ltd 2/41 Quinn St. Preston VIC 3072 (03) 9495 0083

FL.O.W. Plants and Environments 66B Chapel St. Windsor VIC 3181 (03) 9510 6832

Fastway Hydroponics Unit 2/444 Geelong Rd. West Footscray VIC 3021 (03) 9314 1119

Fruits of Nature Pty Ltd T/A Westside Hydroponics 202 Main Rd. Ballarat, VIC 3350

(03) 5338 7555 Gardensmart/ AutoPot Systems 810 Springvale Rd. Braeside VIC 3195

(03) 9701 8811 Global Hydroponics 10 Knight Ave. Sunshine VIC 3020 (03) 9356 9400

Greenleaf Hydroponics 9a Church St. Traralgon VIC 3844 (03) 5176 0898

Greenleaf Hydroponics Factory 7, Ind. Pk. Dr. Lilydale VIC 3140 (03) 9739 7311 GreenLite - Ringwood

291 Maroondah Hwy. Ringwood VIC 3134 (03) 9870 8566 **Grow 4 XS** Rear 24 Simms Rd.

Greensborough VIC 3088 (03) 9435 6425

GROWLUSH[®] Growlush Australia

Factory 5, 102-128 Bridge Rd. Keysborough VIC 3173 (03) 9546 9688 www.growlush.com

Guerrilla Gardens

factory 1/4 Wren Rd. Moorabbin VIC 3189 (03) 9912 6090 guerrillagardens.com Holland Forge Pty Ltd.

68-70 Rodeo Dr. Dandenong South VIC 3175 (03) 9791 8800



Latrove Valley Home Brew Supplies

Living Jungle 345 Sommerville Rd. Footscray West VIC 3012 (03) 9314 0055

12/87 Hallam South Rd. Hallam VIC 3803 (03) 8712 2421

M.H.C. Unit 4, 9 Rutherford Rd. Seaford, VIC 3198 (03) 9775 0495

Melton Hydroponic Supplies

Midtown Hydroponics

Factory 1, 821B Howitt St.

Wendouree VIC 3355

110 Dynon Rd. W. Melbourne VIC 3003

Monster Crop Hydroponics 567 Waterdale Rd.

Heidelberg West VIC 3081

(03) 8528 3474

Pakenham Hydroponics

1/27-31 Sharnet Circu Pakenham VIC 3810

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ten FACTS ON CUCUMBERS

by Philip McIntosh

The year 2014 may have been the National Garden Bureau's Year of the Cucumber, but since ancient times, the cucumber has been one of the most versatile and popular of fruits.



- Cucumbers are cucurbits, which is shorthand for saying they are members of the plant family *Cucurbitaceae*. This classification puts them in league with melons, squash, and gourds.
- History is replete with mentions of the cucumber around the world and it is known to have been grown in the gardens of ancient Egypt, Greece, Rome, and throughout Europe.
- The genus *Cucumis* contains more than 50 species, but *Cucumis* sativus is the only one under worldwide cultivation.
- Cucumis is Latin for "cucumber" and the specific epithet sativus means "cultivated."
- The progenitor of the modern cucumber likely originated in India, coming into cultivation around 3,000 years ago.
- Many fruits and vegetables can be pickled, but there is only one "pickle" that made from the cucumber.
- The pickling process dates to perhaps 2,400 BC, and originated in India, the native home of the cucumber.
- Although there are subcategories, greenhouse cucumbers can be classified into one of three major groups: the American slicer (fat and usually with seeds), Japanese (recognised by its longer, more slender shape), or European (also called English with fewer seeds and thinner skin).
- What about gherkins? The term gherkin is commonly used to describe any small cucumber used for pickling, but there is *Cucumis* anguria, an African species used for much the same purposes.
- The list of pests and diseases able to devastate cucumbers is long: cucumber mosaic virus, mildews and molds, and the usual array of destructive mites and insects. No cultivars are known to be highly resistant to all of these threats. ⁽¹⁾

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