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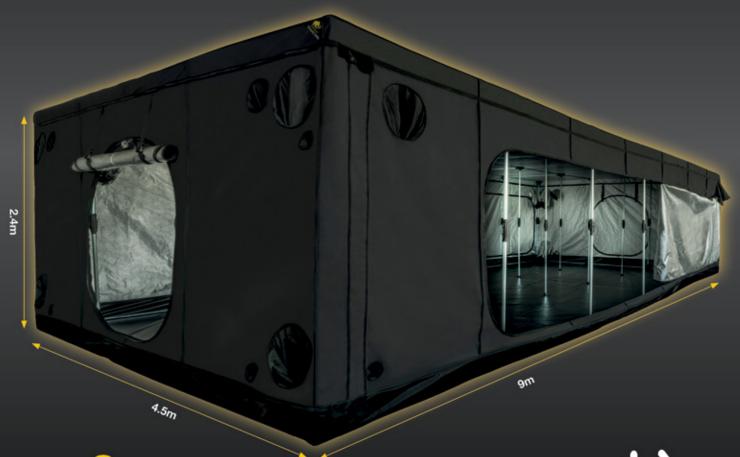


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### **MAXIMUM YIELD**

#### **Features**

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#### Grow Your Own Hydroponic Salsa Garden

by Dr. Lynette Morgan

Mexican cuisine crops are well-suited to growing in hydroponics. Dr. Lynette Morgan explains how to successfully grow these flavourful and spicy products while maximising their unique taste.

40

## Future Farming: The Biggest and Best Vertical Farms

by Sally Nex

With an anticipated worldwide food shortage coming in 30 years, vertical farms might be a way to help increase the food supply. We look at 10 of the world's largest (and planned) indoor farms which produce millions of pounds of produce annually.



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# GreenPlanet

# GROW MICRO BLOOM

3PARTS YSTEM







## A BRAND NEW APPROACH



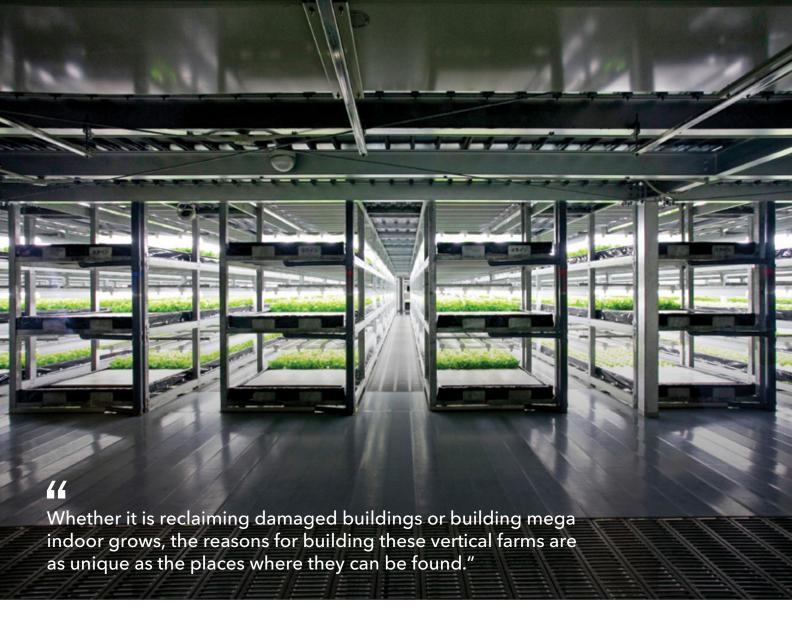
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# from the **EDITOR**



From Arizona to Asia, Belgium to Beijing, Singapore to Sweden, and Michigan to Mexico, this issue of Maximum Yield is truly an international effort.

We asked our writers stationed around the globe to check the pulse of the indoor growing industry and check back in with their own interpretation. The results were diverse, informative, and extremely interesting.

United Kingdom-based writer Sally Nex, who has been feeding her own family from her garden for more than 20 years, set out to explore how different parts of the world were adapting to increasing pressures on agriculture and the food supply. Her research resulted in her article and photo feature "Top 10 Vertical Farms" on page 40, a brilliant synopsis of the major companies and influential people in the emerging indoor grow sector, the money invested, the problems they solve, and the futuristic architecture housing these operations.

Whether it is reclaiming damaged buildings in Kyoto, Japan, finding new ways to grow in sun-starved Sweden, or building mega indoor grows in China, the reasons for building these vertical farms are as unique as the places where they can be found.

Longtime contributor Dr. Lynette Morgan, a specialist in hydroponic greenhouse production and author of five hydroponic books, took a different approach. Based in New Zealand, Lynette added a little spice to her article on page 32 by exploring the possibility of growing Mexican cuisine with hydroponics. Turns out, chilis, epazote, cilantro, and, of course, tomatoes, are all easily grown indoors. As she points out, Mexican cuisine crops are ideally suited to warm, brightly lit indoor gardens and can bring an aromatic and spicy punch to many dishes.

Thanks for taking the journey with us in this issue of Maximum Yield, we hope you enjoy it. •



#### bare **ROOTS**

#### **Featured Contributor**



**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**



Ian Ashdown
Chris Bond
Wiley Geren
Karen Lloyd
Philip McIntosh
Sally Nex
Bryan Traficante



#### A PHYTOCHROMES



**Phytochromes** are a family of photoreceptor molecules found in plants. Each type of phytochrome serves different (and often multiple) functions in each species of plant, but they all absorb red and far-red light in exactly the same manner.

A phytochrome can be seen as a reversible biological switch that can enable or inhibit various plant functions.

It is a crucial element to plant self-regulation systems, used to control flowering, circadian rhythm, seed germination, leaf expansion, stem growth, movement, and the detection of neighbouring plants.

Check out Ian Ashdown's article on page 52 for more information.

### **MAXIMUM YIELD**

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# branching **OUT**



@growingexpsd

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#### @marihemp420

So beautifully crafted. Wall of living art! #welldone



#### Matt S

From personal experience, its so much more satisfying to see that little sprout from the seed and watch it grow. Its a must for first-timers.



#### @SmartPots

You all are awesome! I don't want to know how big Audrey II would have gotten if it were in a Smart Pot!



#### - Paul W.

Growing isn't rocket science anymore, anyone can produce a spectacular crop. Start with "tomatoes" and get an understanding of how YOU are Mother Nature when growing indoors. Then get your "tomatoes" up and going after you have had some experience.

#### **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.

#### Ask the Experts

Stumped by something strange happening in your garden? Fill out our Ask the Experts form and we will find you answers.

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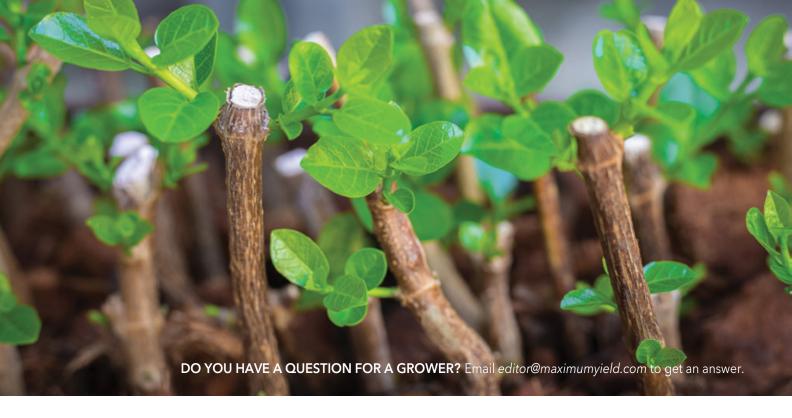
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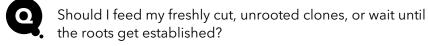
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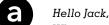




# ask a **GROWER**



Thanks, Jack M.



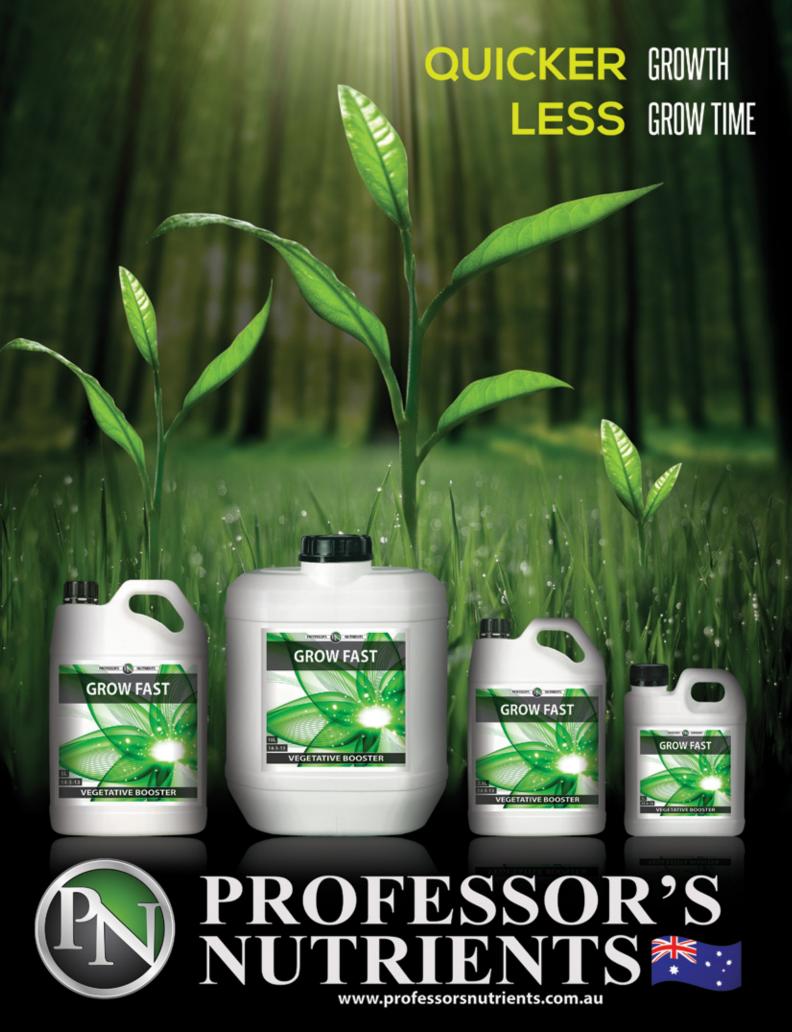
When propagating with clones, it's best to only use clean, sterile water for both misting or fogging the tops of the clones and for saturation of the propagation medium (or if using a water culture propagation system). Freshly cut clones have no roots with which to take up nutrients, so feeding is not required until the first young roots have formed and then nutrients should be first applied at quarter strength, increasing to half vegetative strength as the clones become more developed. Once ready for planting, the clones then need to be hardened off with full-strength vegetative nutrient solution to help prevent any transplant shock. While very low levels of minerals (such as those which might be naturally be present in a water supply), won't generally harm newly cut clones, the use of other fertilisers can cause issues with increasing the water loss from the cut stem surface and restricting water uptake by the cutting which can

lead to wilting of the remaining foliage on the clone. The clone can manufacture some of its own food supply (photoassimulate) during the propagation process which is why clones are provided with a low level of light and have some leaf area retained for this process. However, leaves also lose moisture during the cloning process, which is why we restrict leaf area by removing or cutting back some of the foliage and provide misting or fogging for the plant tops. Using clean and preferably sterile water (such as reverse osmosis water) is also a good idea when taking clones, as the cut surface is prone to infection by pathogens under the damp conditions maintained for cloning.

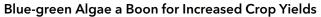
Kind Regards Dr. Lynette Morgan, Suntec International Hydroponic Consultants



**Dr. Lynette Morgan** holds a B. Hort. Tech. degree and a PhD in hydroponic greenhouse production from Massey University, New Zealand. A partner with SUNTEC International Hydroponic Consultants, Lynette is involved in remote and on-site consultancy services for new and existing commercial greenhouse growers worldwide as well as research trials and product development for manufacturers of hydroponic products. Lynette authors five hydroponic technical books. Visit *suntec.co.nz* for more information.



# max **FACTS**



In an effort to increase crop yields, scientists have engineered tiny carbon-capturing engines from blue-green algae into plants in a move that promises to boost yields of wheat, cowpeas, and cassava. Australian National University (ANU) researchers determined the discovery is a big jump forward in improving the way crops undergo photosynthesis. " For the first time, we have inserted tiny compartments (carboxysomes) from cyanobacteria – commonly known as blue-green algae – into crop plants that form part of a system that could lead to a 60 per cent increase in plant growth and yield," says ANU lead researcher Dr. Ben Long, adding the process helps plants speed up how fast  $\mathrm{CO}_2$  can be turned to sugar while minimising reactions with oxygen. Computer models show that upgrading plant photosynthesis to use this mechanism will increase plant growth and yield. The test worked with tobacco plants and the hope is it will work on crops like wheat.

-sciencedaily.com

-agriculture.com

#### Researchers Crack Wheat Genome Code After 13 Years

After 13 years of research, scientists have cracked and sequenced the large wheat genome code. An article in the journal *Science* details how more than 200 scientists from 73 research institutions across 20 countries worked to sequence the genome for Chinese Spring, a bread wheat variety. An initial investment of US\$100,000 by the farmer directors of the Kansas Wheat Commission led to the completion, which will help pave the way for producing wheat varieties that are more adapted to climate change, with enhanced nutritional quality, higher yields, and improved sustainability. "Researchers said the wheat genome was too big, too complex, and too expensive. And now more than a decade later, to see it finally come to fruition, is exciting," says Justin Gilpin, CEO of the Kansas Wheat Commission. A key crop for food security, wheat is the staple food of more than a third of the global human population and accounts for almost 20 per cent of the total calories and protein consumed by humans worldwide.

#### Studies Show Bumblebees Acquire Taste for Pesticide-laced Food

In what is like a nicotine addiction in smokers, bumblebees acquire a taste for pesticide-laced food. And a study shows the more the bees get, they more they want the poisonous material. British researchers found bees, when given a choice between two sugar solutions, chose the solution laced with neonicotinoid pesticides. This means there may be more pesticide-contaminated nectar entering bee colonies that previously thought. "Given a choice, naive bees appear to avoid neonicotinoid-treated food. However, as individual bees increasingly experience the treated food they develop a preference for it," says Dr. Richard Gill from the Department of Life Sciences at Imperial College London. Controversial neonicotinoid pesticides are chemically similar to nicotine, the addictive compound in tobacco. In 2013, the EU imposed a partial ban on three widely used neonicotinoids because of evidence that they may be harmful to bees. The findings are reported in the journal *Proceedings of the Royal Society*.

-theguardian.com





www.professorsnutrients.com.au

## max FACTS

#### Healthy Soil Can Mitigate Effects of Climate Change on Crops

Food production needn't be a victim of climate change. Research from Michigan State University (MSU) suggests crop yields and the global food supply chain can be preserved through soil management. The research, led by MSU Foundation Professor Bruno Basso and published in *Agriculture and Environmental Letters*, found that carbon dioxide compensated for the climate-caused yield losses because it acted as a natural fertiliser to help crops grow. But when soil organic carbon losses were included in the analysis, the increased carbon dioxide in the atmosphere was not sufficient to prevent yield losses. "So, through agronomic management, which is 'doing the right thing at the right time for your crops,' soil quality and health can be improved," says Basso. He explains how farmers can practice better agronomic management to protect soil against the effects of climate change by using cover crops, conservation tillage, adding organic carbon to soil, or by increasing yields through advanced genetics and agronomy.

- sciencedaily.com



#### BC Wine Makers May Turn to Samurai Wasp to Slay Stink Bugs

With stink bugs working their way through British Columbia's Okanagan Valley, researchers are turning to the tiny samurai wasp to take out the pests before they descend en masse on B.C.'s orchards. In downtown Kelowna, more than 1,000 brown marmorated stink bugs were counted in the summer. The stink bug is a destructive agricultural pest that attacks tree fruits, berries, grapes, vegetables, corn, and ornamental plants. The species caused \$37 million in damage to the mid-Atlantic US apple industry in 2010 and could do the same in the Okanagan. One possible weapon against the stink bugs is the tiny samurai wasp, which is the size of a sesame seed. Susanna Acheampong, an entomologist with the BC Ministry of Agriculture, says the wasps attack the stink bug eggs. The wasps are not native to North America.

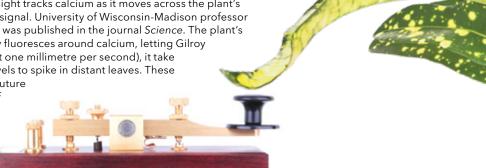
– cbc.ca

#### **How Plants Signal Danger Over Long Distances**

Botanists have shown how glutamate, a neurotransmitter in animals, activates a wave of calcium when a plant is wounded – the best look yet at how plants communicate. Videos show a plant being attacked by a caterpillar. The plant then sends a signal (seen via fluorescent light) to other leaves to prepare for another attack. The fluorescent light tracks calcium as it moves across the plant's tissues, giving a chemical and electrical threat signal. University of Wisconsin-Madison professor of Botany Simon Gilroy did the research, which was published in the journal *Science*. The plant's communication system uses a protein that only fluoresces around calcium, letting Gilroy track it. As the signal moves across the plant (at one millimetre per second), it take a few minutes for defence-related hormone levels to spike in distant leaves. These defence hormones help prepare the plant for future

threats by, for example, increasing the levels of noxious chemicals to ward off predators.

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#### **TO GROW**



#### 1 | Stealth Garden Avert Backpack

Avert odour-control technology is worldfamous for discrete. safe, and trustworthy transportation. The newest release from Avert is their unique backpack design. Featuring 27L of carbon-lined, odorlock technology, laptop holder, extra-thick fabric and outer utility straps for urban necessities. Travel with peace of mind, knowing your precious cargo is safe. Avert backpack designs are lockable for added security. Avert is the market leader for odourcontrolling, carbon-lined bags, available now at select retailers.

#### 2 Cyco Ryzofuel

Ryzofuel is designed for both indoor and outdoor plants. It's an amazing root stimulator (in terms of accelerating new root growth) that works well on mature plants, seedlings, trees, and bulbs. This product contains enzymatically digested Tasmanian kelp which retains naturally higher levels of cytokinins, auxins, and gibberellins. Among the many beneficial, quality ingredients are pure kelp (for plant stimulation), natural hormones, soluble potash, and more than 50 trace minerals. Ryzofuel encourages growth and closer internodal spacing. It's available in several sizes.

#### 3 Nutrifield Grow Products

Nutrifield's extensive range of hydroponic nutrients and other agricultural applications are developed by expert scientists who are passionate about growing healthy plants. Nutrifield is highly regarded for its patented Pro Pot system, highquality substrates, unique bio-stimulant blends, and liquid nutrients. Nutrifield's extensive product range provides gardeners and farmers the flexibility to customise their horticultural setups and support plant growth through all stages of plant development. These products are distributed exclusively by Dome Garden Supplies.

#### 4 Jungle Room Indoor Harvest Grow Tents

Jungle Room and BudBox have partnered together to develop and deliver a vast range of high-quality, well-constructed indoor harvest grow tents for gardeners. Jungle Room, powered by the U.K.'s BudBox (one of the most trusted names in the grow tent market), is now available and exclusively distributed by Dome Garden Supplies. Choose from 10 grow tent sizes at various reasonable prices. Horticulturists will easily find the right tent to fit their indoor growing needs.



#### 5 Nanolux CMH 1,000W Fixture and Lamp

This is the first 1,000W ceramic metal halide (CMH) fixture on the market. Nanolux helped develop the dual arc tube 1,000W CMH lamp. The ballast is a low-frequency unit designed specifically to run low-frequency CMH arc tubes. This fixture can be used as a standalone flowering fixture. The reflector is optimised and photometrically designed for an even commercial overlap pattern with a 136-degree aperture. It's designed for 5-ft. on-center spacing commercial overlap grid, is NCCS/0-10V-ready, and ETL listed.

#### 6 | Ed Rosenthal's Zero Tolerance Herbal Ready-to-use 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. Bottled in quart and gallon sizes.

#### 7 Cyco Kleanse

Cyco's Kleanse is a saltclearing agent formulated to solubilise most micronutrients, cationic nutrients, or metals in a growing environment. Kleanse can be utilised during the growth and bloom period to flush the root system from accumulated mineral salts, while feeding the microbial life in the substrate with needed carbohydrates. It's used throughout the vegetative and flowering periods of plant growth to provide a clean rhizosphere that aids in mineral uptake. Cyco Kleanse is a unique and purposefully formulated cleansing agent for use with the Cyco Platinum Series line of plant nutrients.

#### 8 THC Reskue

THC Reskue is a great first aid product for ailing plants. The unique formula breathes new life into plants by treating the causes of chlorosis, nutrient deficiencies, and stress illnesses. It handles nutrient deficiencies that lead to yellow plant syndrome due to lack of chlorophyll. It helps plants recover from heat and other stresses, wilting, drooping, root damage, and nutrient deficiency. Use THC Reskue for prevention and curing plant ailments, as an additive or foliar, in hydroponics, soil or other substrates. Look for it at Excel Distributors.

#### good

#### **TO GROW**









#### 9 Western Electrical Lighting Products

Western Electrical has designed, developed, and manufactured highquality lighting products for the horticultural industry throughout Australia and across the world, including brands like Indoor Sun, Hortitek, and Lucius. The company recently announced a partnership with Philips that will allow distribution throughout Australia and New Zealand. This partnership includes a joint commitment to research and develop state-of-the-art horticultural lighting technologies. Western Electrical, a division of the Dome Group, is exclusively distributed by Dome Garden Supplies.

#### 10 Reiziger Root Booster

Norwegian sea kelp contains many rootsustaining properties and is a proven organic booster to maximise root function and generate maximum yields. Reiziger Root Booster has been a staple of many professional gardeners and growers for more than 20 years to activate, revive, and stimulate indoor hydroponic plants, outdoor plants, seedlings, trees, flowers, bulbs, natives, and more. This nutrient-rich, organic root stimulator has the power to save, revive, or help newly-potted plants and transplants grow early white healthy roots, give more uniformity, and improve survivability.

#### 11 Bio Diesel Rhino K

Rhino K is a strong potassium bloom booster that promotes more flowering sites with denser development and heavier blooms. Rhino K contains no phosphorus and is more microbe friendly than most phosphorus/ potassium bloom additives. With a pure, 15 per cent potassium solution, the product should be used during the last three weeks of budding to harden and swell flowers during the later-bloom stages. Fulvates maximise key nutrient movement and sugar transfer, helping with bud formation, enhanced trichrome, and increased oil and terpene production.

#### 12 House and Garden Multizyme

House & Garden Nutrients utilises enzymes, coenzymes and vitamins. Enzymatic function serves to help breakdown particles into usable forms for plants and stimulates healthy living microbial activity. Expect lush green growth, heavier foliage development, faster vegetative time, and heavier flowers. Multizyme is used by leading cup-winning farms worldwide and is famous for delivering noticeable results. Try H&G Multizyme for bigger, healthier results in your garden. H&G Multizyme is available through leading hydroponic retailers worldwide.

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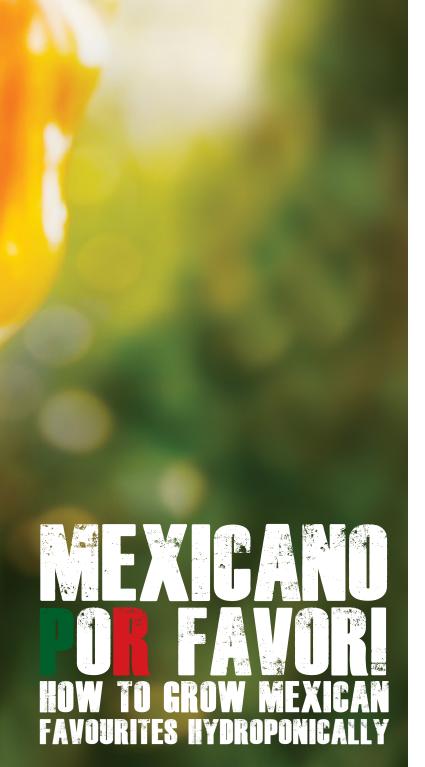
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Mexican cuisine crops are well-suited to growing successfully in hydroponics. Dr. Lynette Morgan explains how to grow these flavourful products while maximising their taste.

#### by Dr. Lynette Morgan

ydroponic methods and indoor gardening allow a world of exciting cuisines to be experimented with by growing a diverse range of popular and lesser known ethnic crops. By dialling up just the right climatic conditions, nutrients, and some cultural know-how, some popular as well as slightly more unusual fruits, herbs, and vegetables can be grown. Mexican cuisine crops are ideally suited to warm, brightly lit indoor gardens and can bring an aromatic and spicy punch to many dishes. With a base of succulent tomatoes, fiery chilies, exotic tomatillos, combined with familiar herbs such as cilantro and the more acquired tastes of epazote and papalo, Mexican crops are both exciting and highly productive to grow hydroponically.

#### **MEXICAN FRUITING CROPS**

The mainstay of many Mexican dishes are of course tomatoes, which are native to South America, but to maximise flavour, the selection of tomato variety is important. Mexico produces both red tomatoes and green tomatoes (tomato verde) for local markets, and both have different culinary uses, with green tomatoes usually cooked and most often fried during preparation. Green tomatoes are simply unripe fruit that haven't gone through any colour change, however, there are a few heirloom varieties that remain green when ripe (such as green zebra). Vine ripened red tomatoes most commonly utilised in Mexican cuisine are "meaty" types with high levels of solids, such as beefsteak varieties. The sweet cherry types are also popular and perform particularly well under hydroponic production.

#### **TOMATILLOS**

Tomatillos (Physalis philadelphica), also known as Mexican husk tomato, and Mexican groundcherry produce small greenish yellow or purple fruit inside a papery husk and are a staple of Mexican cuisine. Tomatillos have been cultivated in Mexico since pre-Columbian times and are the main ingredient in salsa verde. While green tomatillos may look a little like an unripe tomato, the flavour is completely different. Young fruit are often quite tart, but as they ripen, a more fruity, savoury, and completely unique flavour develops with a firm, if somewhat seedy, flesh. Tomatillos can be grown alongside tomatoes and chilies in the same nutrient solution as these all prefer similar warm temperature conditions with an optimum of 26°C and moderate to high light levels. There are several tomatillo varieties to select from with the most productive for hydroponics being Toma Verde, which produces almost golf ball-sized green fruits. A number of smaller fruited, heirloom, purple-skinned types also exist which are slower to mature but highly decorative to grow. While the green-skinned tomatillo varieties are fairly tart in flavour, the darker purple types are sweeter and high in pectin and may be used to make preserves and jams.



**TOMATILLOS** can be grown alongside tomatoes and chilies in the same nutrient solution as these all prefer similar warm temperature conditions with an optimum of 26°C and moderate to high light levels."

Most tomatillo varieties will need support as these grow to a similar size as large capsicum plants (up to five feet) and will produce a profusion of husked fruit. It's also advisable to grow at least two to three tomatillo plants in a closely spaced group to assist with cross pollination. Fruit are ready for harvest when the husk turns a papery tan and starts to split open at the sides.

#### **CHILIES**

Chili peppers originated in Mexico and Central America and the fruit provide not only heat of varying degrees, but also intensive colour, flavour, aroma, and texture, making them a very versatile plant. While there are number of Mexican chili types, the main varieties grown hydroponically are habanero, poblano, mulanto, and jalapeno. The heat experienced from eating chilies comes mainly from compounds called capsaicinoids, although other pungent compounds have been identified in hot capsicum fruit. What gives hydroponic growers  $\alpha$ major advantage when it comes to growing Mexican chilies is the pungency of the fruit, and even the flavour, can be manipulated somewhat by the growing conditions provided. The concentrations of capsaicin in the chili fruit increase with plant stress factors such as a lack of moisture, high temperatures, high electrical conductivity (EC), and high salinity. Capsaicin concentrations also increase throughout the development of the fruit and are always highest at maturity. So, allowing chilies to ripen and fully mature on the plant (even to the point of starting to shrivel) will maximise the heat factor.

Beefsteak tomatoes with a high solids content are the mainstay of many Mexican dishes.

Chili plants can be grown in a wide range of hydroponic systems, although media-based systems are most commonly used as some chili types can grow into large plants at maturity. For NFT, the smaller, bush types of chili are often a better choice and these may need support if the plants become tall and lanky under low light. The best way to obtain plants is to raise these from seed, which germinates readily between 22-28°C in an inert media such as stonewool or small pots which can be later transplanted into the hydroponic system without too much root disturbance. After germination, seedling temperatures can be reduced back to 20-25°C and light levels gradually increased to harden off seedlings before transplanting. For strong flowering and fruit set, the night temperature should be a little lower than the day temperature with an optimum of 25°C during the day and 18-20°C at night. Chilies, while self pollinating, do benefit from some pollination assistance such as gently tapping or shaking the plants when in flower to help release the pollen.

Most chili types perform well in standard grow and bloom hydroponic nutrient products. Electric current levels should be between 0.8-1.0 for seedlings, gradually increased to an EC of 2.0 before planting out. For those looking to intensify heat, increasing the EC up above 3.0 and allowing the growing media to dry slightly between irrigations will help concentrate flavour and heat in the fruit, but may reduce yields somewhat by lowering fruit fresh weight.













#### **MEXICAN HERB CROPS**

Like many cuisines, Mexican dishes make use of a wide range of native and introduced herb and spice crops. Some are well known hydroponic crops such as cilantro (leaf coriander) and mint, while others are new flavour sensations that can really bring the taste of Mexico into dishes which are already old favourites. Epazote and papalo are two such Mexican herbs that perform well under hydroponic cultivation, take up minimal space in an indoor garden, and are relatively trouble-free to grow.

**EPAZOTE** is often considered to be an essential ingredient in many traditional Mexican chili and bean dishes."

#### **Epazote**

Epazote (Chenopodium ambrosioides) is a classic Mexican herb, little known in the rest of the world and with a flavour profile that can be somewhat challenging to the uninitiated, and an acquired taste. Epazote is often considered to be an essential ingredient in many traditional Mexican chili and bean dishes, and has a flavour described as camphor or turpentine-like with a strong aroma. While its usual flavour doesn't seem that attractive on its own, it does add something unique and special to many Mexican dishes that make it worth trialling in hydroponic herb gardens. Easily grown from seed, epazote is a small but rapid growing herb requiring temperatures between 18-26°C, moderate to high light, and with similar nutritional requirements to other hydroponic herbs such as basil and cilantro. Being easy to propagate from seed and an annual crop, epazote grows exceptionally well in NFT and other solution culture systems and can be combined with lettuce, herbs, and other small vegetables.

#### Cilantro/Coriander

Cilantro (Coriandrum sativum) is sometimes referred to as leaf coriander, Mexican parsley, or simply as coriander, and is a quick-growing, warm-season annual herb. Cilantro and coriander are the same plant and are both used in Mexican cuisine, however, cilantro refers to the flat, fan-shaped leaves, while coriander refers to the seeds that are ground and used as a spice. Cilantro leaves have a characteristically different aroma and flavour profile than the ground seeds, but both are frequently used in the same dish. Cilantro is a fresh herb with a limited shelf; its flavour and aroma diminishes with shipping and storage, and the delicate foliage is easily damaged.





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#### FOR THOSE WITH LIMITED SPACE,

epazote, papalo, and cilantro can be grown as microgreens, harvested in the seedling stage after the development of two to four leaves."

For this reason, it is an excellent herb to grow in an indoor garden to be harvested just before use when its flavour quality is highest. Since cilantro has a habit of going to seed (bolting) fairly rapidly, it's important to select cultivars that will not only grow large, quality foliage, but are also slow to bolt in the warm protected environment of an indoor garden. Varieties such as calypso, santo, and marino are well-suited to hydroponic production being slow to bolt and allowing two to three harvests or cuts before plants need to be replaced. Cilantro seed is large, rounded, and easy to handle and is best sown into individual cubes, cells, or pots of sterilised, free-draining substrate as seedlings are not suited to transplanting. Germination occurs within five days at 20-25°C, with seedlings requiring warmth (more than 20°C) and moderate light levels to prevent elongation and tall, weak growth. Under hydroponic production many growers sow several seeds into each planting site or pot and grow these mini bunches for just a few weeks before cutting. For small-scale indoor gardens, cilantro can be harvested at any stage from young seedlings (microgreens) through to mature plants depending on the flavour intensity required. Younger plants are more tender and the flavour milder, while older plants, particularly those about to flower, develop stronger, sometimes slightly bitter taste.

#### Papalo

Papalo (Porophyllum ruderale) is a lesser known, ancient Mexican herb which predates the introduction of cilantro and appears to be well-suited to hydroponic herb gardens and NFT systems in particular. The flavour of papalo is similar to a combination of cilantro, arugula, and lime with an aromatic,

Cilantro or leaf coriander is widely used in Mexican cuisine and is already a popular hydroponic crop.

yet nutty, sharp flavour that is particularly well-suited to incorporating into salsas and many other Mexican dishes as a cilantro alternative. Papalo is a heat-loving plant and has less tolerance to cooler conditions than cilantro, (and is thus sometimes called summer cilantro), however, its bolder and more complex flavour makes it a great addition to tomato, bean, and chili dishes. Papalo, with its higher degree of heat tolerance, is also a great plant to grow in conditions where cilantro typically bolts and goes to seed rapidly. The aromatics and flavour of the papalo foliage mostly originate from the large oil glands which look like dark green spots on the undersides of the leaves and are a distinctive characteristic of this unique herb. Papalo comes in two different leaf forms: narrow and broad leaf, with the broad leaf being more suited to hydroponic production and having a more palatable flavour. Papalo seeds are available from seed supplies, however, germination can be somewhat slow, so buying in small plants is another option for hydroponic systems.

For those with very limited space, epazote, papalo, and cilantro can be grown as microgreens, harvested in the seedling stage after the development of two to four leaves. Even at this delicate stage, these herbs develop their characteristic flavour in a milder form, well-suited to many culinary uses.

Setting aside some space for Mexican cuisine crops adds an extra dimension of flavour to a hydroponic garden. While we are all familiar with the traditional tomatoes and chilies, growing a few tomatillos alongside these perennial favourites will give months of great tasting fresh salsa ingredients. Experimenting with a few of the more unusual Mexican herbs such as epazote and papalo is also one way of obtaining that truly authentic flavour, and there are also many more lesser known Mexican herbs which are worth some investigation.



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## FUTURE FARMING: With an anticipated worldwide food shortage coming in 30 years, vertical farms might be a way to help increase the food supply. Sally Nex takes a look at 10 of the world's largest (and planned) indoor farms which produce millions of pounds of produce annually.

The world is filling with people, and fast: the latest UN figures predict the world's population will hit 9.8 billion in a little over 30 years time. And about 70 per cent of those people will live in urban environments. That's a double whammy for food production: more mouths to feed, but less land to do it with as farmland disappears under apartment blocks.

One radical solution is to bring the farms indoors. Controlled environment agriculture, also known as vertical farming, doesn't need any land — just a reclaimed building. It can produce up to 350 times the amount of food per acre, using just one per cent of the water, without pesticides, every single day of the year.

Indoor food factories are now springing up, backed by millions of investment dollars on every continent including Antarctica. There's even one on the International Space Station. It is increasingly looking like this is the future of farming.

Here are 10 of the larger vertical farm companies from around the globe:

#### AEROFARMS, New Jersey, USA

aerofarms.com

Environmentally responsible food production was the idea behind America's largest indoor farming enterprise. Now with nine farms across the US, and more in development around the world, AeroFarms deliberately chooses sites near major population centres to break the old model of transporting food miles before it arrives on the plate.

Watercress, kale, arugula, and around 20 other types of leafy greens grow on fabric made from recycled pop bottles, their roots extending into a water-and-nutrient mist. Stacked on shelves seven storeys high, the farm produces 1.7 million pounds of leafy greens each year.

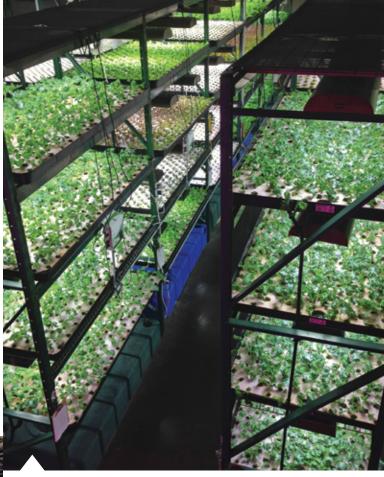


BADIA FARMS, Dubai, United Arab Emirates

badiafarms.com

Food security is  $\alpha$  hot issue in the Middle East. Supplies of water and fertile land in these arid, desert countries are limited, and the Gulf States rely on imports for 80 per cent of the food they eat.

So, governments are keeping a close watch on Badia Farms (Badia is Arabic for oasis), the region's first commercial vertical farm which opened earlier this year. It offers a viable solution to farming in the desert: the harvest, grown in coir under LED lights, uses 90 per cent less water than conventional farming. They've started with leafy greens and herbs, but other vegetables are on the way.



#### GREEN SPIRIT FARMS, Michigan, USA

greenspiritfarms.com

Father and son team Milan and Dan Kluko watched farmers struggling through the crippling droughts sweeping the US from California to New York State, and decided their family farm would be different. This farm wouldn't have to depend on the weather for results.

Water conservation is a daily preoccupation, and the eight-acre farm now produces its food using 98 per cent less water than conventional growing. Milan and Dan also push the boundaries on crop varieties: as well as leafy greens, their list includes peppers, tomatoes, and peas, grown in stonewool on stacked trays.





#### INTELLIGENT GROWTH SOLUTIONS, James Hutton Institute, Dundee, Scotland intelligentgrowthsolutions.com

Britain's first automated vertical farm opened this year, but this is no conventional commercial operation churning out lettuces for restaurants. It's a life-sized, \$3.3-million research lab, experimenting with new ways to grow more efficiently under LED.

The facility is based on the grounds of Scotland's respected agricultural research hub, the James Hutton Institute. Planned trials include testing automation systems and experimenting with how different colour spectrums affect crop growth. It'll also be working on expanding the range of fresh produce, potentially opening the way for fresh, pesticide-free strawberries and tomatoes, grown in Scotland all year.



#### WORLD FOOD BUILDING, Linkoping, Sweden

plantagon.com

This vision in glass and steel is still being built, but it's already one of the most exciting vertical farms in the world. The award-winning \$40-million World Food Building, by Swedish food-tech company Plantagon, is a 16-storey, 200-foot high plantscraper capable of feeding 5,000 people.

Racks of vegetables extending the height of the building benefit from natural sunlight as well as LED lights, dramatically cutting a major cost of vertical farming, while robots take care of much of the sowing, planting, and tending. The building is set to open by 2020.



#### PLENTY, Seattle, USA

plenty.ag

Silicon Valley start-up Plenty Inc. has big ideas. The masterplan is to build vertical farms in every major city (they're already getting involved in projects in China and the Middle East).

For now, though, they're starting with Kent, near Seattle, where they've opened their second 100,000-square-foot vertical farm, designed to produce 4.5 million pounds of greens each year. The plants — mainly leafy greens like kale and mustard greens — grow sideways on 20-foot towers in walls of unbroken greenery with water and nutrients delivered by (energy-free) gravity instead of pumps.





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#### SKY GREENS, Singapore

skygreens.com

Among the first commercial indoor farms in the world, in the famously densely-populated city-state of Singapore, Sky Greens sowed its first seeds in 2012 and now produces up to 10 tons of leafy veg every day — a lifeline for an island with a chronic scarcity of green space.

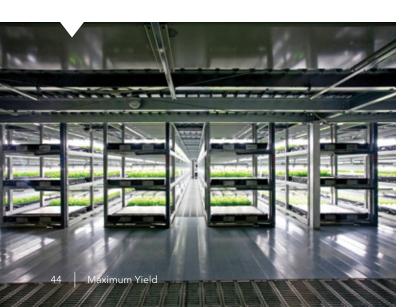
The same (recycled) water that irrigates the plants is used to power a hydraulic system, like giant water wheels carrying trays of Chinese cabbage, lettuce, and spinach up and over 30-foot high A-frames. They're planted, unusually, in soil rather than hydroponics to improve the flavour, and turn evenly through the sunlight as they go, hardly any LEDs required, adding up to an almost zero-carbon system.

#### SPREAD, Kyoto, Japan

Following the 2011 earthquake and tsunami which all but destroyed the nuclear plant at Fukushima, irradiating fresh produce for miles, food security took on new meaning in Japan.

Though Spread's massive vertical farm in Kameoka, Kyoto Prefecture, had been producing fresh greens since 2007, consumers remained suspicious of food grown without soil or sunshine. That all changed when vertically farmed vegetables became the only ones quaranteed free of nuclear fallout radiation.

Now they've opened an even bigger facility in nearby Keihanna. Tended mainly by robots, it covers nearly three acres and produces 30,000 heads – three tons – of lettuce every day.



#### SUNQIAO, Shanghai, China

sasaki.com

Not so much a vertical farm as a whole district of them, Sunqiao is a vision of the future. China's second city is intensely urban, eight times bigger than New York City, and home to 24 million people. The Sunqiao Urban Agricultural District, designed by US-based architects Sasaki, is China's solution to feeding all those hungry mouths.

A 20-year building program began last year to create a 250-acre residential complex studded with vertical tower greenhouses dedicated to growing kale, spinach, and lettuce for local people. Plants grow along looping rails, rotating to make the most of natural light; watered with collected rainwater, while nutrients are delivered from fish tanks in an aquaponics room.



#### URBAN CROP SOLUTIONS, Kortrijk, Belgium

urbancropsolutions.com

Maarten Vandecruys was still a student at business school when he came up with his big idea. He found himself an investor and an old carpet factory and two years later, Urban Crop Solutions had its first prototype, turning out  $400 \text{ crops } \alpha$  day.

Vandecruy's off-the-shelf plant factories are completely closed environments, gardened by robots using a crate system in up to 24 layers. They are designed to slot seamlessly into any building. The most recent models are smaller-scale container farms, fully-roboticized miniature plant factories that fit comfortably inside a city-center basement.

Vertical farming is unlikely to replace conventional farming any time soon, if only because set up costs run into the millions, and the range of foods is largely restricted to leafy greens (larger vegetables like potatoes take too much light and energy to produce economically). But it is increasingly looking like a viable, sustainable solution to some of the toughest challenges in feeding a growing world. For this technology, surely, the only way is up.  $\Box$ 



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Practiced around the world, hydroponics is especially advantageous where climates restrict plant growth, where low-quality soil won't support large-scale production, and in countries where once fertile soil has been over-farmed. The availability of fresh water is also an important variable as clean, recycled water is a valuable resource. Hydroponics reduces consumption of fresh water from our already endangered water supply — a recent report states agriculture uses 70 per cent of available fresh water, while industry uses about 25 per cent and residential uses five per cent worldwide. The benefits of recycled hydroponic water for small and large operations include cost savings and higher crop yields.

To reduce the risk of recycled water spreading bacteria, viruses, and other waterborne diseases to crops, it's important to disinfect the water before it is recycled through the system. There are several ways to disinfect your hydroponic water, but in this article, we'll examine the benefits and challenges of the top three: heat pasteurisation, ozonation, and UV disinfection.

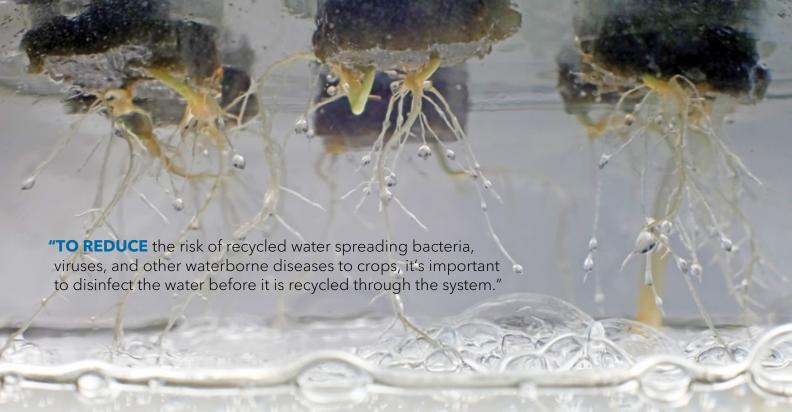
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#### 1) HEAT PASTEURISATION

With pasteurisation, water is heated and then cooled to kill bacteria and viruses. Developed in the 1860s, heat pasteurisation is one of the most popular ways to disinfect hydroponic systems due to its simple design and ability to terminate the most heat-resistant pathogens. Different temperatures and contact times are needed depending on the source of recycled water and what it's being used for. Due to potentially high costs of heating and cooling recycled water, this method is best used by smaller operations.

#### **Benefits**

- Water does not need to be pre-filtered.
- Minimal biological and mineral fouling.

#### Challenges

- Expensive for large operations.
- Over time, high mineral content in the water leads to the buildup of deposits on the heat exchangers of the pasteurisation system, which will decrease efficiency and increase maintenance costs.

#### 2) OZONATION

Ozone  $(O_3)$  is basically just oxygen with three molecules. A natural gas, ozone is created when the air in the growroom is bombarded with ultraviolet radiation from the sun. It can also be created artificially through an ozone production system by using a high-voltage corona discharge. Ozone is an intense, thorough, and environmentally friendly way to effectively destroy bacteria, fungi, and other waterborne diseases. It's the strongest available water disinfectant on the market.

#### **Benefits**

- Microorganisms can never become resistant to ozone.
- Ozone reacts quickly and has no residual capacity.
- Controlled ozone in the growroom can also kill spiders and mites.
- Leads to savings on fertiliser.

#### Challenges

- More expensive to operate than heat pasteurisation.
- Ozone is a strong oxidiser and thus highly corrosive.

#### 3) UV DISINFECTION

With this disinfectant method, recycled water is passed through a radiation chamber that holds one or two high-pressure UV lamps. In recent years, more growers have turned to UV radiation as an alternative to chlorination, largely out of concern for the environment. Ultraviolet disinfection has a unique effect on microorganisms. It does not necessarily kill the target but rather alters its DNA strands so that the microorganism is incapable of reproducing. A bug that can't reproduce quickly dies.

#### **Benefits**

- UV disinfection is cost-effective.
- If the UV dose is too low, inadequately disinfected water is automatically returned to the system.
- No toxic chemicals are used, and no byproducts are left behind.

#### Challenges

- UV light is only able to remove microorganisms and does not remove any other contaminants like heavy metals, salts, chlorine, or man-made contaminants.
- UV light is also only effective if the water being treated is clear.

While hydroponics is trending upward for both commercial and hobby growers, it's important to note that variables must be strictly controlled to ensure the correct hydroponic balance is not disturbed once it is achieved. Without soil as a buffer, any failure in the hydroponic system can result in rapid plant death. To ensure maximum quality and yield, no matter what hydroponic system you use, water samples should be taken regularly and discussed with a professional.

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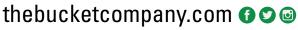
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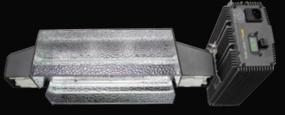
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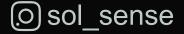


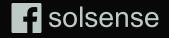


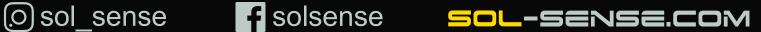
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Most LED grow lights feature blue and red LEDs whose peak wavelengths — approximately 450 nanometers (nm) for blue and 660 nm for red — have been chosen to coincide with the spectral absorption peaks of chlorophyll A and B molecules. In doing so, they optimise the conversion of electrical energy into plant photosynthesis.

Some manufacturers, however, are now offering grow lights with "far-red" LEDs featuring peak wavelengths of approximately 735 nm. Unfortunately, the manufacturers offer little if any information on why these LEDs are useful.

To make an informed choice when purchasing these grow lights, it is necessary to understand some of the science behind far-red radiation and how plants perceive and respond to it.

#### Red and Far-red Radiation

What we call "visible light" is electromagnetic radiation with wavelengths ranging from 400 to 700 nm. We perceive this radiation as ranging from very deep blue (400 nm), bordering on ultraviolet radiation, to very deep red (700 nm), bordering on infrared radiation.

Coincidentally, this is also the range of wavelengths that plants can utilise for photosynthesis (photosynthetically active radiation (PAR)).

There is no formal definition of "red" in terms of wavelength, but it is often considered to consist of wavelengths ranging from 600 nm (bordering on orange) to 700 nm. The term far-red, on the other hand, has been formally defined to consist of wavelengths between 700 nm and 800 nm. We can barely see this radiation as a very deep red if the radiation is intense enough, but it is, for practical purposes, invisible to the human eye. Plants, on the other hand, readily perceive and respond to far-red radiation.

We see vegetation as being green because the chlorophyll A and B molecules strongly absorb blue and red light. A typical green leaf absorbs 90 per cent of incident red light; the remainder is reflected and transmitted (Fig. 1). Beyond 700 nm, however, chlorophyll is basically transparent. This means beyond approximately 750 nm, green vegetation reflects 40 per cent and transmits 55 per cent of far-red radiation. The region of rapid change in spectral reflectance between 700 and 750 nm is called the "red edge," and is used to monitor vegetation coverage from space using remote imaging (Fig. 1).

#### the cerm far-red

has been formally defined to consist of wavelengths between 700 nm and 800 nm."

#### The Phytochromes

Angiosperms — flowering plants —
also take advantage of the red edge using
a family of photoreceptor molecules called

phytochromes (Latin for "plant colour"). They have been doing so since they first appeared in the fossil record some 160 million years ago. It is not an exaggeration to say that without these molecules, we would still be living in a world of conifers, cycads, and ginkgoes.

The number of different phytochromes varies by plant species — rice has three, thale cress has five, maize has six, and so on. Each type serves different (and often multiple) functions in each species, but they all absorb red and far-red light in exactly the same manner.

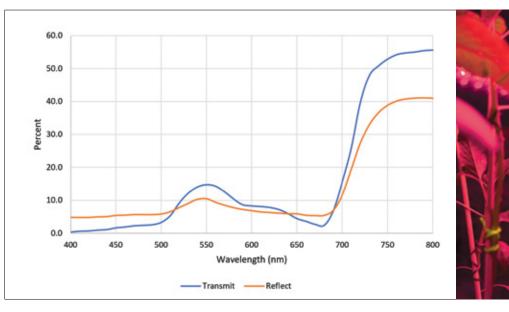


Fig. 1 - Typical vegetation spectral properties.



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Each phytochrome molecule has two states called isoforms. Left in the dark for several hours, it reverts to a state called Pr, where it strongly absorbs red light (Fig. 2). If a phytochrome molecule in this state absorbs a red photon, it changes to its Pfr state, where it absorbs far-red radiation. If the molecule absorbs a far-red photon, it reverts to its Pr state. When in its Pfr state, the molecule is biologically active, and may interact with the plant's molecular machinery. Given this, a phytochrome can be seen as a reversible biological switch that can enable or inhibit various plant functions. One such important function is the detection of neighbouring plants.

#### Shade-avoidance Syndrome

Flowering plants that tolerate full or partial sun need to gain access for their leaves to direct sunlight in order to photosynthesise. The problem is they often have competition from other plants for the same resource. That is, the leaves of other plants may block access, either at present or in the future. In response, the plant may elongate its stem and decrease branching in order to tower above the competition. In doing so, it necessarily diverts resources from other priorities, including producing secondary metabolites for pathogen resistance and insect herbivore deterrence, improving drought tolerance, and reducing root biomass. Together, these responses are called the shade-avoidance syndrome (SAS).

If the plant realises or predicts it cannot avoid being shaded, it responds by growing in a more compact form and flowering early. Being crowded by other plants, it is more susceptible to pathogen and herbivore predation. The best strategy is to build chemical defenses and stay close to the ground while producing seeds as soon as possible in order to survive into the next generation.

Shade-loving flowering plants, on the other hand, may not exhibit any of the SAS responses, at least to the same degree. The daylight they receive has likely been diffused by the forest canopy, and so there is less advantage in devoting resources to avoid being blocked by the leaves of neighbouring plants.

#### Red/Far-red Ratio

On a clear day, direct sunlight has a ratio of red light to far-red radiation (R:FR) of about 1.3. That is, there is about 30 per cent more red light than far-red radiation that is received by the plant leaves.

Even daylight reflected from natural inorganic materials, such as rock and soil, exhibits roughly the same R:FR ratio.

#### "BOCH red and Far-red

LEDs can be used to simulate twilight for vertical farms at the end of the daily photoperiod."



When the direct sunlight is being blocked by the leaves of neighbouring plants, however, the "red edge" effect takes hold. A single layer of leaves can change the R:FR ratio from 1.3 to 0.2 or less. That is, there is now about six times less red light than far-red radiation incident on the plant leaves. Two layers of leaves and the difference becomes 30 times or more.

Flowering plants use phytochrome to detect the R:FR ratio and so decide whether SAS responses are necessary. In addition to detecting whether the direct sunlight is being directly blocked, the plants can determine from the R:FR ratio whether there are neighbouring plants that might pose a future threat and so initiate appropriate SAS responses.



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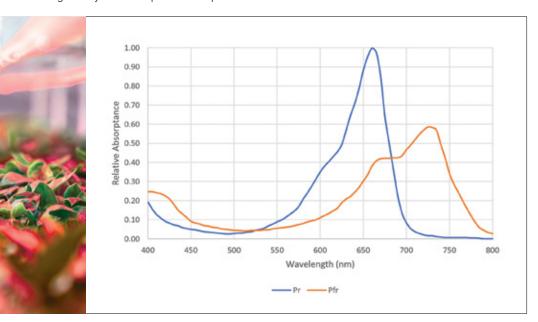
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Fig. 2 - Phytochrome spectral absorptance.



#### End of Day

The R:FR ratio of direct sunlight is about 1.3 during most of the day, but it approaches 0.6 or so during twilight when the atmosphere preferentially scatters blue light and the sky turns yellow and red. This only lasts for half an hour or less, but it is important because plants use these changes to synchronise their internal circadian clocks both with the 24-hour day and the seasons. This involves a burst of gene expression activity that is controlled by phytochrome.

Blackout curtains can be used in greenhouses to eliminate twilight, and both red and far-red LEDs can be used to simulate twilight for vertical farms at the end of the daily photoperiod. Interestingly, low PAR values are required, on the order of one µmol·m-2·sec-1, for this purpose. Various SAS responses to red and far-red pulses have been recorded for different species, including stem elongation and changes in leaf area. End-of-day pulses of far-red radiation, for example, have been shown to result in useful hypocotyl elongation of tomato rootstocks for grafting.

#### **Night Breaks**

Floriculturists have long used incandescent lighting at night to disrupt the photoperiod of short-day plants such as poinsettias and chrysanthemums. During the night, the phytochrome molecules revert to their biologically inactive Pr state. If the plants are exposed to incandescent lighting (which has an R:FR ratio of 0.7) during the night, the phytochrome molecules are re-activated, which results in their circadian clocks being reset. Repeated nightly exposure ("night breaks") in the middle of the night prevents the plants from stopping vegetative growth and setting their flower buds.

For long-day plants, night break lighting may have the opposite effect of advancing rather than delaying flowering. The operative here is "may," as different species

and even cultivars respond differently to night breaks.

It is important to note that only red light can be used for night breaks; when phytochrome is in its Pr state, it cannot absorb far-red photons. Red LEDs with their 660 nm peak wavelengths are thus ideal for night-break lighting, whereas far-red LEDs will have no effect (Fig. 2).

#### "IF THE PLANT realizes

or predicts it cannot avoid being shaded, it responds by growing in a more compact form and flowering early."

#### Far-red Radiation Sources

Given plants are subjected to an R:FR ratio of 1.3 in direct sunlight and much lower ratios when shaded by neighbouring plants, it is interesting to consider what we subject them to with various electric light sources. Incandescent lamps have an R:FR ratio of 0.7, which is what plants would perceive when they are adjacent to neighbouring plants but not directly shaded.

High-pressure sodium (HPS) lamps, on the other hand, have an R:FR ratio of about 4.8, metal halide lamps have R:FR ratios varying from 2.6 to 3.4. and white light LEDs (regardless of colour temperature) have R:FR ratios varying from 3.6 to 4.0. Various fluorescent lamps have R:FR ratios varying from 5.5 to 13.0 and above.

The common reason for these high R:FR ratios is that, putting aside technology limitations, the lamps are designed for visual applications — there is no reason for them to generate invisible far-red radiation. If they did, it would simply lower their luminous efficacy (lumens per electrical watt) values.



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#### "END OF DAY FAR-red

With only blue and red LEDs, the R:FR ratio is essentially infinite. SAS responses can sometimes be elicited by blue light alone,

pulses of radiation at low irradiance levels may have a greater effect on plant growth than during the day, as this is when gene expression is particularly active."

but the likelihood is many plants will not recognise the presence of neighbouring competitors when irradiated by most grow lights.

#### **Far-red Applications**

This leaves open many questions regarding the possible applications of far-red LEDs. While various species and cultivars may grow well (or not) under the familiar blue and red ("blurple") LEDs, they may not exhibit any shade avoidance syndrome responses. In some situations, these responses may actually be desirable. For instance, sun-loving plants that are grown in shade may be more compact, but they may also exhibit greater pathogen and



drought resistance, and they may generate desirable secondary metabolites as defense mechanisms. Their flowering may be advanced or delayed, the number of buds may change... the list goes on. It is αlso possi-

ble that end-of-day far-red pulses of radiation at low irradiance levels may have a greater effect on plant growth than during the day, as this is when gene expression is particularly active (blue light pulses at dawn

have also been shown to change plant morphology). One advantage is this requires less energy than having the far-red LEDs continuously on during the day.

For horticulturalists and floriculturists, experimentation with far-red LEDs offers opportunities for developing species- and cultivar-specific light recipes as trade secrets. If horticultural luminaire manufacturers have not yet said why far-red LEDs are useful, it is because there is much that still needs to be researched and discovered. With a basic knowledge of the science behind far-red radiation and the phytochromes, it becomes practical to experiment with light recipes and photoperiods, and to understand why the plants respond the way they do.





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by Wiley Geren and Bryan Traficante

Native to Asia, tea is the most widely consumed drink on the planet next to water. Fortunately, you don't have to go all the way to Asia to benefit from its soothing and sometimes medicinal qualities. In fact, you can grow it right in your own garden.

ne product we crave for better living is tea. Among the oldest drinks in the world, tea is both delicious and associated with health benefits like improved digestion and relaxation. Tea detoxes, rejuvenates and relaxes, and assists in sleep, and those are just a few examples of what we see on tea packaging in our local stores. But why go shopping for tea when you can grow it in your backyard? Enjoy all the benefits of the freshest, most organic tea there is by growing a tea garden.





#### **TOP TEA PLANTS FOR YOUR GARDEN**

#### **Hibiscus**

Fast-growing and large flowers, hibiscus grow well in temperate climates and steep into delicious, beneficial teas. Once a hibiscus flower blooms, it will shrivel and drop off the plant. They are known to be resilient and grow easily, making them a great plant for beginning gardeners. With hibiscus, the most work you will have to do is pruning them back. Make sure they don't overshadow other plants. Often, people will use lattices to help support their upward growth.



#### Bee Balm

A perennial herb, Bee Balm is a beautiful flower known for blooming in bright red, purple, and pink. The bright colours attract butterflies and bees, hence its name. It is suggested that gargling this tea can help alleviate a sore throat. Provide Bee Balm with some shade and soil with good drainage, and you won't have a problem cultivating plenty for multiple servings of tea. Raised beds provide excellent drainage and are wonderful for tea gardens.

#### Mint

Everyone knows mint. Not only is it a popular flavour and widely used cooking ingredient, it is a delicious tea. As you'll notice with most teas, it grows with minimal effort and isn't too picky about where it is. Mint will grow quickly so keep it contained, but it will give your garden a revitalizing smell. The stem, old leaves, and new leaves can be used to create some of the most refreshing tea there is.



#### Lavender

This flower's aroma is famous for its use in aromatherapy and will remind most people of rest and relaxation. It's a blue flower capable of creating purple-blue tea and will grow fervently as long as they have good drainage and sunlight. Many people feel lavender tea can relieve stress and suggest its vapours should be inhaled right after steeping. Regardless of actual health properties, lavender is associated with de-stressing. That's why this beautiful flower is sought after by those trying to quieten their mind and relax their body.

#### Chamomile

Chamomile is an adorable flower similar to a small daisy. It will grow easily, but temperatures of more than  $36^{\circ}$ C can be damaging (not many garden plants will do well in  $36^{\circ}$ C-plus weather for long). Chamomile steeps into a light-golden tea, perfect for sipping hot or cold. Many teas, like this one, can be cooled after steeping and kept in a fridge. This way, you have a cold beverage other than water or soda to enjoy during the hotter days.

Overall, many herbs and flowering plants can be made into tea and are easily grown in raised beds, pots, and planters. The varieties we mentioned are some of the most popular garden grown options and don't contain caffeine; they're more for relaxation and flavour. For caffeinated teas such as white, green, black, and oolong you'll want to look into growing Camellia sinensis (and its subspecies) which is an evergreen shrub/tree. The different types of caffeinated teas all come from this plant species and are simply processed differently to make the different styles. Enjoy!

#### BREWING HOME-GROWN TEA

For those that have never brewed loose-leaf tea, it's easy:

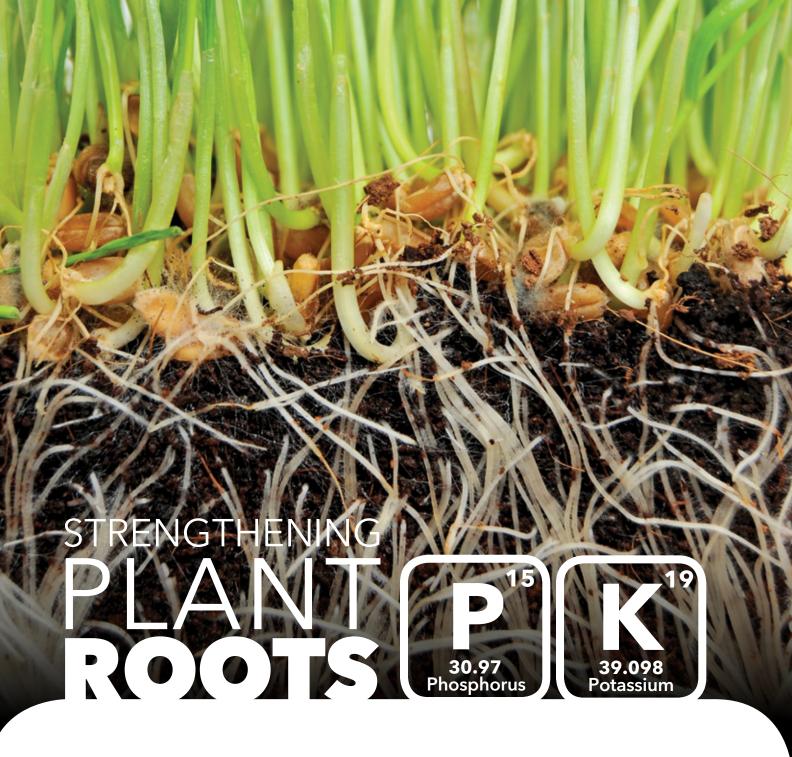
Pick your ingredients fresh or use them after they've dried depending on the tea (48 hours drying time, but still fresher than any tea you can buy).

- Bring your pot of water up to a soft boil and add your desired amount of tea.
- 2. Cover and steep on very low heat for 15-20 minutes.
- Pour into heat-proof cup or jug and use a mesh screen/ filter to filter out the tea pieces.
- 4. Let cool, sip, and enjoy.



## "AMONG THE OLDEST DRINKS IN THE WORLD,

tea is both delicious and associated with health benefits like improved digestion and relaxation."



No matter what crop or plant you're growing, healthy and strong roots are the foundation for maximum yields. Chris Bond breaks down how phosphorus and potassium each boost root power and growth.

by Chris Bond

Dp, down, and all around; that's how many horticulturists learn the rudiments of the big three macronutrients: nitrogen (N), phosphorus (P), and potassium (K) and their respective functions. Nitrogen is for the shoots, branches, and leaves; phosphorus is for the roots; and potassium is for overall plant health. While this is not entirely untrue, it is hardly the full story. Many elements play multiple roles in plant health and vital functions. Healthy roots require more than just phosphorus to thrive. All roots need air, water, and space between the soil or media particles to spread, grow, and latch on to. Phosphorus is indeed important for root health and development, but potassium does its part as well to help stimulate and strengthen plant roots.

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"PHOSPHORUS HAS BEEN SHOWN REPEATEDLY TO POSITIVELY IMPACT THE TOTAL ROOT LENGTH, average root diameter, and specific root length."

#### PHOSPHORUS'S ROLE IN ROOT DEVELOPMENT

To determine just which aspects of root development and health phosphorus is responsible for, many researchers will design experiments withholding gradually higher or lower levels of phosphorus and compare the results. This iteration is replicated on various aspects of root, shoot, leaf, or any other variable development on a diverse cross-section of species of plants under an array of conditions, all around the world. Phosphorus has been shown repeatedly to positively impact the total root length (TRL), average root diameter (ARD), and specific root length (SRL). Studies over decades have shown phosphorus has a meaningful effect on all root system morphology. Applications of phosphorus on plants ranging from legumes to grasses to herbaceous perennials to trees have shown significant increase in ARD and TRL. Results from a few follow here:

- 1. Primary Root Development and Phosphorus In a study on the effects of varying amounts of phosphorus on the species Arabidopsis, researchers confirmed phosphorus deficiencies inhibit plant growth throughout the plant's root system. Low phosphorus levels were found to prevent or severely impede cell division in the meristematic region and at the same time encourage unwanted, premature cell differentiation within the root tip, which can result in suppression of any primary root growth. Low phosphorus levels conversely increase weaker, lateral root development. The same experiment found root length in phosphorus-deficient plants to be 0.6 times the length of control plants with proper or adequate phosphorus levels.
- 2. Root Length Distribution and Phosphorus When comparing the root development of corn exposed to various treatments of nitrogen and phosphorus, researchers found corn that had been treated with phosphorus fertiliser and nitrogen fertiliser had six times the root length density at 12-18 inches and four times as great at 18-24-inch depths than with corn fertilised with only nitrogen.
- 3. Root Collar Diameter and Phosphorus Another study focused on comparing root collar diameter among a range of seedling types. Those seedlings that received fertilisers containing phosphorus showed both increased plant height and root collar diameter. Plants in this particular study were treated with either no phosphorus (control plants), four grams of phosphorus, six grams, eight grams, or 10 grams. Not surprisingly, the plants with the widest root collar diameters corresponded respectively with the higher amounts of phosphorus.

Plant roots without sufficient access to phosphorus are difficult to spot. Phosphorus deficiencies do not always present as discolouration and are usually evident by overall slow growth or stunting of the plant. It can be corrected with the addition of fertilisers or amendments containing conventional or organic sources of phosphorus.

Phosphorus is indeed a necessary component of root development and health. It should, however, be noted many soils have adequate amounts of phosphorus and the addition of high phosphorus fertilisers may be at best unnecessary and at worst detrimental to healthy plant development.

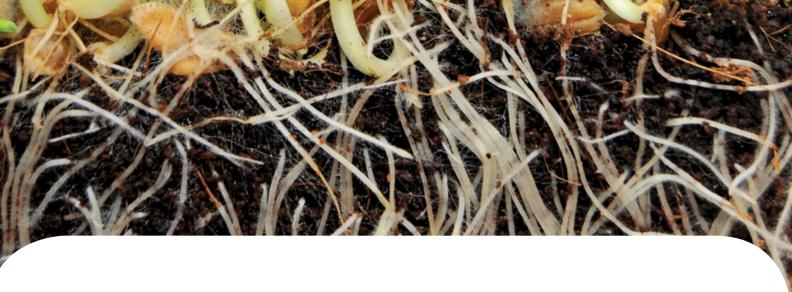
High levels of phosphorus in run-off can wreak havoc on local waterways and ecosystems. Too much phosphorus will encourage algae blooms in some waterways which will impede the ability of light to penetrate the water surface and starve the flora and fauna that need it to live. Make sure before adding phosphorus to your plants, fields, or gardens (or any other nutrient) there is indeed a deficiency and a need for it.



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"POTASSIUM HELPS TO MITIGATE A PLANT'S ABILITY TO EFFECTIVELY DEAL WITH DROUGHT, temperature extremes, and toxic levels of metals and salts."

#### **POTASSIUM'S ROLE IN ROOT DEVELOPMENT**

The various roles potassium plays in plant and root development, as well as the myriad processes that it enables or assists, are still being learned. But there are some things about the role of potassium that are known. Potassium helps to mitigate a plant's ability to effectively deal with drought, temperature extremes, and toxic levels of metals and salts. A lack of potassium is known to increase a plant's susceptibility to a host of diseases and various infestations. This makes plants vulnerable to the ravages of a variety of stressors. Additionally, a lack of sufficient potassium has been shown to suppress root growth in a range of plant species. A likely, equal number (to those examining effects of phosphorus on plant roots) of studies and experiments have been undertaken on countless species of plants to determine the effects of potassium on root development and morphology.



What follows are a few of those findings:

- 1. Sweet potatoes (*Ipomoea batatas* (*L.*)) grown in soil deficient in potassium displayed reduced levels of the total biomass productivity and root yields.
- 2. Root ability to conduct water or perform other hydraulic functions is greatly suppressed when there is a lack of potassium. In a study of common beans, there was a positive correlation between the ability to uptake water and the ability to absorb available potassium.
- 3. Potassium has been found to ameliorate toxicity from heavy metals such as cadmium and zinc in bean plants. Plants exposed to these metals at high levels will evince reduced root and shoot lengths.
- 4. Applications of potassium on various rice cultivars increased the biomass, length, and root diameter. Interestingly, higher levels of potassium were shown to reduce the concentration of calcium, magnesium, and sulfur, but allowed for increased efficiency in the rice plants' usage of those same elements even while reducing the amount they could absorb.
- 5. Corn plants with low levels of potassium consistently showed poor primary root growth. Studies were conducted given varying levels of potassium fertilisers to these corn plants and were shown to have an increase of primary root length proportionate to the amount of potassium given. Corn plants given four to 10 grams of potassium showed primary root lengths of 0.6 to 1.4 times larger than the control corn plants which were given no additional potassium.

How do you know if your roots don't have enough potassium? It will be evident in the roots themselves, generally as a stunted appearance. But short of digging them up, potassium deficiencies begin in the lower older leaves and work themselves upwards.



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"IT IS IMPORTANT TO NOT UNDERESTIMATE
THE IMPORTANCE OF THE ROLES phosphorus
and potassium play in the health and
development of your plants' root systems."

#### **ADDING PANDK**

It cannot be stressed enough that without a soil test or analysis of your soilless media, there is no way to accurately tell if your plant's roots have access to enough phosphorus and potassium to properly function and grow. A do-it-yourself kit or a professional lab analysis will reveal the present and desired levels of phosphorus and potassium. Either option is relatively inexpensive and will save the expense of adding unneeded fertiliser. If results do indicate a need to add phosphorus and/or potassium, remember the following:

- Plants don't know the difference between organic, chemical, or conventional sources of potassium and phosphorus. These distinctions may be important to the grower or end user, but on the chemical level, the plant doesn't "see" these differences.
- 2. Chemical and conventional forms of phosphorus and potassium tend to be water soluble and in higher concentrations than in organic forms. Water soluble forms of nutrients are activated upon the introduction of moisture. Your plant roots will take what they can and any excess will either leach out or runoff. Keep these fertilisers dry or they will become useless before applying them. Organic forms of phosphorus and potassium tend to be much lower in concentration, but your plant roots have an opportunity to use all of it. Organic nutrients are usually activated by the slow, microbial activity in the soil. Most organic sources of phosphorus and potassium are slow release, so don't expect immediate results.



3. Phosphorus and potassium may be in sufficient quantities in your soil, but your pH may be preventing your plants from using them. Different soil pH's lock up or inhibit the release and uptake of various vital plant nutrients. Phosphorus is most available to your plant roots at pH's in the range of 6.5-7.5, and then at pH over 8.5 (though this is extremely alkaline and few plants could thrive in such a high pH). Potassium is most available to plant roots at pH of 6.0 and higher.

It is important to not underestimate the importance of the roles phosphorus and potassium play in the health and development of your plants' root systems. Don't think, though, that other nutrients don't play supporting roles in root health. All necessary nutrients work in concert to support critical functions from the cellular to the macro-levels. Don't, however, skimp on two of the most important ones for roots — phosphorus and potassium.





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Including keynote speaker Ed Rosenthal, alongside the expo, the 2018 Australian Cannabis & Hemp Symposium will feature expert local and international speakers discussing everything medicinal cannabis and industrial hemp, bringing to Melbourne the world's leading medical professionals, academics, research associates, pharmacists, activists and entrepreneurs for conversations and Q&A sessions! This year's symposium will also feature presentations from Australian Cannabis Access Clinics. Keep an eye on the ever-expanding speaker list here.

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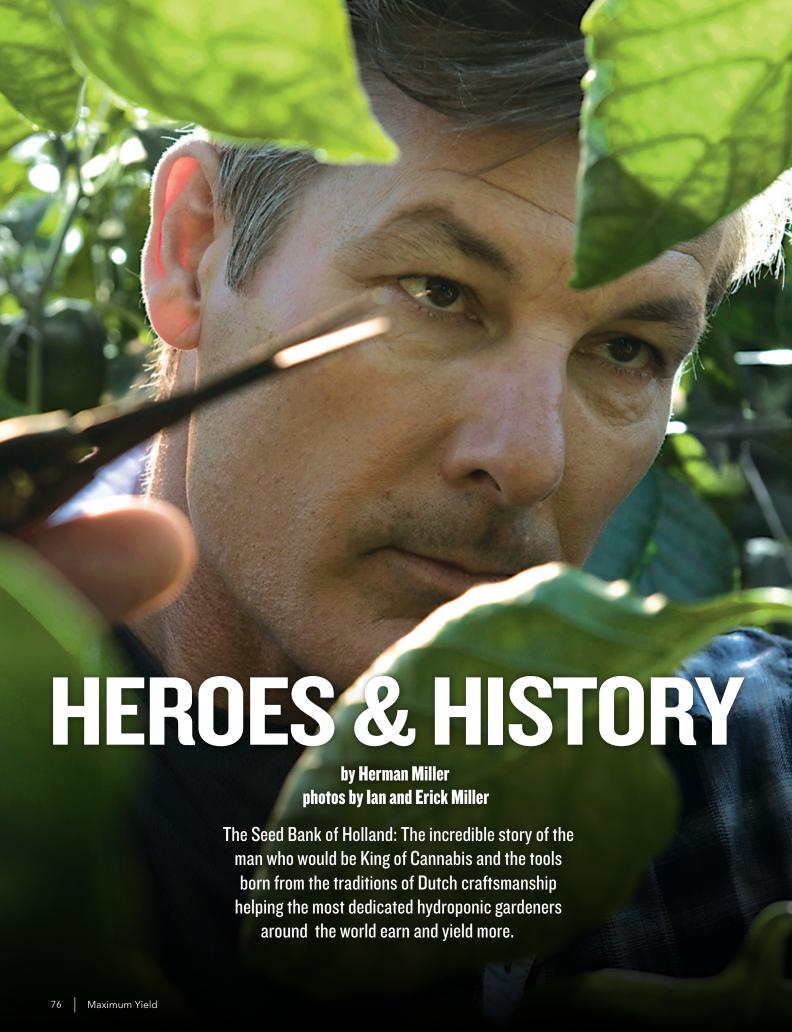














The Dutch know a thing or two when it comes to cannabis. Over the years, they have had a major influence on the way the world cultivates and consumes cannabis — from the laid back vibes of Amsterdam coffee shop culture to the potent Nederwiet that raised the bar on THC levels.

Many new growers these days are not aware of the history of commercial seedbanks. Back in the early 1980s, a new entity in Holland began pioneering a revolutionary approach to breeding, setting a new benchmark in plant cultivation assisted by the use of specialised nutrient formulations.

The now-legendary Seed Bank of Holland was the brainchild of a dedicated Australian hydroponic grower named Nevil Martin Schoenmakers, who created the seed bank to meet the challenges of growing strains of cannabis crops across the planet, in different climates and varying environmental conditions.

Nevil's work in breeding and improving the genetics of plants made him a legend in the 1980s, as his potent and hardy varieties became the basis for most of the strains widely used around the world today.

Nevil, who started growing cannabis in 1978, soon discovered that the commercially available Thai, Colombian, and Nigerian equatorial strains did not perform well in the northern European climate of Holland. Undeterred, he started growing indoors under high intensity discharge lighting in 1979 but was not satisfied with the results using equatorial sativas indoors. Realizing that the solution to the problem was a question of genetics, he decided that the best way to obtain good genetics was to travel the world sourcing landrace seeds, leading to the foundation of one of the world's largest seed distribution businesses, the Seed Bank of Holland, through which he mailed seeds to American customers and other global markets.

Nevil Martin Schoenmakers is an Australian-born cannabis breeder known for founding the first cannabis seedbank, called "The Seed Bank of Holland", in the early 1980s in the Netherlands. It's was the world's first seed company to advertise directly to the public in *High Times* magazine.









# "THE YEARS I have invested in the art of growing are matched by the quality delivered by Reiziger," says expert Dutch head grower, Guus Meijer."

Nevil is credited with creating many of the most popular award-winning High Times Cannabis Cup strains such as Silver Pearl, Northern Lights Haze, Super Silver Haze, Nevil's Skunk, Super Skunk, Silver Haze, and his greatest achievement according to High Times' Senior Cultivation Editor Danny Danko, Nevil's Haze.

His breeding with Northern Lights, a mostly indica strain originally developed in the Pacific Northwest of the United States, became an inspiration for indoor indicas and the Northern Lights genetics are found in the pedigrees of nearly all the best modern indica lines. This hybrid and its daughters have dominated the HT Cannabis Cup from the 1980s to present day. The original Northern Lights 5 X Haze plant of Nevil's has been living on through clones and still wins championship awards. It is this cross that led to many of the modern medicinal strains that are popular today.

Schoenmakers, a Dutch-Australian dual citizen who travelled between the two countries and worldwide, was detained in Australia in 1990 at the behest of the US government, which was seeking his extradition on 44 drug-related counts. After holding him for 11 months while appealing the extradition, the Australians let him out on bail and Nevil promptly disappeared.

**Top:** Quality results are Reiziger's priority. Quality first.

**Center:** Checking the stonewool drippers for correct emissions ensures precision growing conditions and optimal yields.

Bottom: Reiziger's distinctive packaging signifies quality.



Grower getting supplies ready for the next crop. Quality and yield are the ultimate barometers and motivation.

Despite trumpeting its success in getting the Australians to apprehend him, the US Justice Department never succeeded in arresting Schoenmakers. They eventually lost interest and the charges were quietly dropped.

Today, the strains that Nevil was responsible for sourcing and releasing to the public may not be the most popular things to smoke themselves, but they definitely are responsible for some of the best modern strains that have come out recently. There's no denying it and for that, Nevil deserves major credit.

The long-standing connection between the Reiziger range of gardening solutions and The Seed Bank gives Reiziger the unique ability to reward passionate and dedicated hydroponic craftsmen with cup-winning results. For perfectionists desiring maximum yields, this ultra-premium nutrient range is for you.

Kept a closely-guarded secret since the 80s, handed down from one generation of Dutch craftsmen to the next, Reiziger is born from the original nutrient recipes used at the legendary Seed Bank of Holland and are the world's first hydroponic solutions for craftsmen.

If you are already a respected craftsman, that is, a professional master grower, within your community of fellow-growers and you've exceeded the capability of your existing nutrient regime, then Reiziger is the perfect range for you. Reiziger is not for newbies or the inexperienced. Designed without compromise to enhance the cultivation of all short cycle, high-value plant strains, Reiziger utilises an extremely powerful formulation incorporating the latest in low EC phosphorus technology that awards the hydroponic craftsman unparalleled bud size, weight, and swelling with an enhanced sweetness, flavour, and aroma.

"THE LONG-STANDING connection between the Reiziger range of gardening solutions and The Seed Bank gives Reiziger the unique ability to reward passionate and dedicated hydroponic craftsmen with cup winning results."

Reiziger helps stabilise pH, guarding your crops against pH fluctuation, stress, and nutrient deficiencies. The balanced formula provides macro, secondary, and fully chelated micronutrients plus the innovative and revolutionary patented PPX phosphorus facilitates better absorption by the roots. Reiziger is designed to be safe for use in all hydroponic growing media, both recirculating and non-recirculation systems.

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VEG	EC	ML	EC	ML
Week 2	0.3	0.6	1.4	2.0
Week 3	0.3	0.6	1.6	2.5
Week 4	0.4	0.8	1.8	2.75

# "THE BALANCED FORMULA provides macro, secondary, and fully chelated micronutrients plus the innovative and revolutionary patented PPX phosphorus facilitates better absorption by the roots."

EC levels of 1.8 mS or 2.75 ml/L of A&B are normal in the late vegetative phase when using traditional nutrients. Plants at the same stage grown using Reiziger on the other hand only require an EC level of 0.4 mS or 0.8ml/L A&B. Unheard of when growing hydroponically. Its medical grade plant-boosting macronutrients, fused in the correct ratio with chelated micronutrients, give you bigger, heavier, superior quality fruits and blooms with more yield from the same flowering time. Reiziger's boosters, nutrients, and substrates are alive with pioneering know-how to help enhance the cultivation of all fruiting and flowering plants with a focus on high-value medicinal and culinary herbs such as basil, coriander, thyme, mint, and more.

For Dutch hydroponic master gardeners, growing is all about craftsmanship, passion, dedication, and a unique blend of art and science. Reiziger solutions have been instrumental in helping them master their craft. It's a brand Dutch breeders and growers have sworn by since 1984. After 30 years, you could say that plant food flows through the Reiziger veins. Proudly made in Holland, using only the finest quality ingredients, nothing has been left to chance to enhance the production of fast-growing crop strains in any hydroponic system under grow lights. It's only natural that hydroponic growers might want to opt for the same consistent harvests achieved by experienced Dutch craftsmen since the 1980s. Try it for yourself today and search for the ship on the gold bottle or visit www.reiziger.com to find a Reiziger authorised retailer near you.





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 $\mathbf{S}$  ol-Sense provides innovative horticultural lighting solutions and accessories for commercial greenhouse operations, research institutions, and horticulture enthusiasts. With decades of combined experience, co-founder Richie May says Sol-Sense aims to merge their knowledge and passion for growing with delivering cutting-edge technology to the market.





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"We believe that focusing our innovations on the needs and wants of growers is our core strength."

#### What did you and your partners do before starting Sol-Sense?

We all came from different backgrounds ranging from hydroponics and accounting to importing and logistics. We have a combined 20 years of experience in horticulture.

#### How did you get into this industry?

My business partner and I had started an importing company in March 2013. Soon after we started, a friend of ours who is a long-time grower, was planning a commercial set-up and wanted us to import the equipment for him. The deal was a success and as they say, the rest is history. Six years later and we are still in the market with more than enough passion for the industry and no intentions of slowing down.

#### When and where did Sol-Sense begin?

North Western Sydney, March 2013.

#### How does Sol-Sense's philosophy translate to opportunities?

We recognised the issues growers were facing with their current lighting systems, so we decided to research and develop alternative solutions.

#### What products did you initially focus on?

Grow lights have been our main product focus since we started in 2013, four years prior to launching the Sol-Sense brand in 2017.

### What were some obstacles you had to overcome as you got Sol-Sense off the ground?

In the beginning people were very skeptical of our products and us because we were fairly new to the market and no one had ever heard of us. We continued to persist and before we knew it, some time had passed and growers started talking about the great results they were achieving from using our products.

#### How did you gain market share and recognition?

By being customer-orientated and creating a brand growers can trust.

### Sol-Sense started in a garage. Have you moved to a bigger space?

Yes, we started in the garage. We then upgraded to a storage space and later we upgraded to a warehouse where we currently operate.

#### What is your current product line?

We are currently releasing an exciting new range of advanced horticultural lighting fixtures. The range focuses on increased essential oil production, increased efficiency, and reduced operating temperature.

#### Where do you distribute?

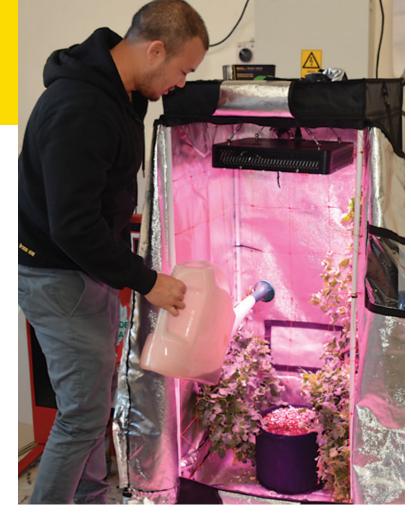
Our products are available at all trusted hydroponic outlets nationwide in Australia.

#### How many people now work for Sol-Sense?

We started off with just two of us and now we are five in total.

#### What are Sol-Sense's strengths?

We believe that focusing our innovations on the needs and wants of growers is our core strength. We also stock a unique line of high-end products put together by an experienced team in the field of growing. We package those efforts with excellent customer service and aftersales warranty.



#### What are some of your proudest moments at Sol-Sense?

Not only is it rewarding to see our hard work and effort paying off, but also to receive feedback from growers who have benefitted immensely from using our products.

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

The industry is full of down-to-earth and honest people that are willing to support the small players so they can become big players. We are still relatively new to the industry and we intend to make our supporters proud.

#### What have you learned about growing a company?

It's extremely tough, but with a bit of brains and whole lot of hard work and persistence we are sure to enjoy the fruits of our labour.

### Any words of wisdom can you share about the future of the industry?

With the growing populace, resource and space-efficient farming methods are in more demand than ever. It is an exciting time for indoor farming technology and innovation and we look forward to what the future holds.

#### Any favourite stories from a day on the job?

There are too many crazy stories to mention but one thing we know is there hasn't been a dull moment since we joined the industry. Every day is a new challenge and something new is learned and achieved.

#### What makes Sol-Sense's employees so awesome?

The guys are an extremely knowledgeable and hardworking bunch that know how to have a good time. •

# Better ROOTS. Bigger PROFITS.

O<sub>2</sub> Grow delivers 50% more oxygen than air stones.

Oxygenates 10 to 14 Gallons per Emitter

NEW for DWC

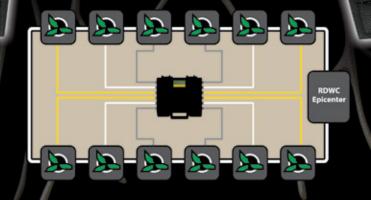
- Maximizes Yield with Oxygen Nano Technology
- Ideal for Deep Water Culture Systems or Drain to Waste
- Enhances Cloning and Veg Growth
- Activates Microbes

2120-A

"Spider" 12 Emitters

2120-B

"Spider" 6 Emitters (not shown)



**University Test Results** 

### % Increased Yield - University of MN

Tomato Brandywine Organic	21%		
Bell Peppers Organic	32%		
Hanging Basket Flowers	16%		
Strawberries Evie 2	18.3%		
Tomato BHN 589	15.8%		

For more info & recent research-based data, go to: o2grow.com

University of Minnesota







2020 20 Gallon Capacity



2040 40 Gallon Capacity



120 Gallon Capacity



250 Gallon Capacity



a division of Oxygen Research Group LLC

Call for Pricing!

### 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 **Hyalite Moorebank** 6/376 Newsbridge Rd. Moorebank NSW 2170 (02) 9824 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

South Lismore NSW 2480 (02) 6621 3311

Lux Cuttings Shop 2/273 Anzac Parade Kingsford NSW 2032 (02) 9663 0473

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

**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

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



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

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

The Grow Shop

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

Uncle Wal's Gardenland 31 Cres. Ave. Taree NSW 2430 (02) 6550 0221

VN Hydro 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 1800661475

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

Advanced Horticulture Supplies - Noosaville Shop 3 11 A VP 45(6) Noosaville QLD 4566 (07) 5641 1256 adhs.com.au

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



Agua Gardening Unit 3, 4 Billabong St Stafford Brishane QLD 4053



Agua 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



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

Hyalite Varsity 5/11 John Duncan Crt. Varsity Lakes QLD 4227 (07) 5593 7385

Hydrocenter Hydroponics 46 Spencer Ro 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

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

Slacks Creek Hydroponics #13/22 Allgas St. Slacks Creek QLD 4217 (07) 3299 1397

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



Sunstate Hydroponics 10/13 Kerryl St. Kunda Park QLD 4556 (07) 5445 3499

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

**Tumbling Waters** Hydroponics 2 Clarkes Track Malanda QLD 4885 (07) 4096 6443

Walsh's Seeds Garden Centre 881 Ruthven St. Toowoomba QLD 4350 (07) 4636 1077

#### **SOUTH AUSTRALIA**



Adelaide Hydro Shop 3,267 Good nnd Rd Kings Park SA 5034 (08) 7230 5907 adelaidehydro com au



**Advanced Garden Supplies** 3/8 Bredbo St. Lonsdale SA 5160 (08) 8382 1191

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

Ascot Park 753 Marion Rd. Ascot Park SA 5043 (08) 8357 4700

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 (08) 8322 4383

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

Bolzon Home & Garden 103 Tolley Rd. St Agnes SA 5097 (08) 8265 0665

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

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

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

D & W Dependable Hardware 45B Kettering Rd. Elizabeth South SA 5112 (08) 8287 6399

Every Thing Hydro Shop 2/494 Main North Rd. Blair Athol SA 5084 (08) 8260 3335

Festive Hydro 2 Kreig St. Evanston Park SA 5116 (08) 8523 5100

**Fulham Gardener Nursery** 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

**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 Shon 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 (08) 8254 1585

Hvdro 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

Hvdro 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

**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

**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

(08) 8341 5991 Tea Tree Gully Hydro 32 Famechon Cres. Modbury North SA 5092 (08) 8264 9455

174 Semaphore Rd Exeter SA 5019

Two Wells Hardware 86 Old Port Wakefield Rd. Two Wells SA 5501

(08) 8520 2287 Urban Grow Solutions 1/111 Main Sth Rd. O'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. (08) 8280 3314 warehouseofgarden.com.au

West Garden Centre Flizaheth 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

Ezv 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.

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 Hohart 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 3189 (61) 422 064 904

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

**Bayside Hydroponics** 5/9 Rutherford Rd. Seaford, VIC 3198 (03) 9775 0495

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

4 - 479 Nepean Hwy. Edithvale VIC 3199 (03) 9783 3006 Casey Hydroponics

Brew 'N' Grow

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

Casey Hydro 78 Spring Square Hallam VIC 3803 (03) 9796 3776

Central Hydro Factory 3/9 Mirra Court Bundoora VIC 3083 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 18 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** 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

F.L.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 Australia 830-850 Princes Hwy. Springvale VIC 3171 (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



Hydroware 1/54 Lara Way. Campbellfield VIC 3061 (03) 9357 8805

Hvalite Airport West Unit 4/504-506 Fullarton Rd. Airport West VIC 3042 (03) 9331 5452

Hyalite Bayswater 4/19 Jersey Rd. Bayswater VIC 3153 (03) 9720 1946 Hyalite Global

10 Knight Ave. Sunshine N VIC 3020 (03) 9356 9400 Hyalite Westend

3 Third Ave. Sunshine VIC 3020 (03) 9311 3510

Hydroponic Central 110 Dynon Rd. West Melhourne VIC 3003 (03) 9376 0447

Hydroware 1/54 Lara Way Campbellfield VIC 3061 (03) 9357 8805

Indoor Garden Company 29 Glasgow St. Collingwood VIC 3066 (03) 9416 1699 Inner City Hydroponics

155 Dardbin R Thornbury VIC 3071 (03) 9480 1078 Impact Distribution PO Box 2188

Salisbury Downs VIC 5108 (08) 8250 1515 JB Lighting 492 - 500 Neerim Rd. Murrumbeena VIC 3163 (03) 9569 4399



Just Hydroponics Deer Park Shop 11, 29/39 Westwood Dr. Deer Park (Ravenhall), VIC 3023 (03) 8390 0861 justhydroponics.com.au



Just Hydroponics Geelong Shop 1, 22 Essington St. Grovedale (Geelong) VIC 3216 (03) 5421 6046 justhydroponics.com.au



Just Hydroponics Hoppers Crossing 3, 8 Motto Ct. Hoppers Crossing VIC 3931 (03) 8742 2830 justhydroponics.com.au



Just Hydroponics Mornington Shop 4, 14 Latham St. Mornington VIC 3029 (03) 5973 6281 justhydroponics.com.au Latrove Valley Home Brew Supplies PO Box 802 Morwell VIC 3804 (03) 5133 9140

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

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

Magick Brew 205a Bayview Rd. McCrae VIC 3938 (03) 5981 1160

Melton Hydroponic Supplies Melton VTC 3194 (03) 9746 9256

Midtown Hydroponics Factory 1, 821B Howitt St. Wendouree VIC 3355 (03) 5339 1300

**Mirror Paints** 110 Dynon Rd. W. Melbourne VIC 3003 (03) 9376 0447 mirrorpaints.com.au



Monster Crop Hydroponics 567 Waterdale Rd. Heidelberg West VIC 3081 (03) 8528 3474

One Stop Sprinklers 1 Burwood Hwy. Wantirna VIC 3152 (03) 9800 2177



Pakenham Hydroponics 1/27-31 Sharnet Circuit Pakenham VIC 3810 (03) 5940 9047

Pam's Home Brew & Hydroponics 61 McArthur St. Sale VIC 3850 (03) 5143 1143

Pakenham Hydroponics 1/27-31 Sharnet Circuit Pakenham VIC 3810 (03) 5940 9047

Prestige Hydroponics Pty. Ltd. S 2.10 Level 2, 343 Little Collins St. Melbourne VIC 3000 (61) 4187 81083

**Revolution Harvest** 9/177 Salmon St Melbourne VIC 3000 (04) 0242 5451

Shepparton Hydroponics 87A Archer St. Shepparton VIC 3630 (03) 5831 6433

Simple Grow

12 Blackfriar Pl



Simply Hydroponics 5/411-413 Old Geelong Rd Hoppers Cros. VIC 3029 (03) 9360 9344 Smart Hydro Garden

3/4 Lacv St. Braybook VIC 3019 (03) 9318 8110 St Albans Hydroponic 55 St Albans Rd. St Albans VIC 3021

(03) 9366 7788 Sun-lite Hydroponics 23B Wood St. South Geelong VIC 3220 (03) 5222 6730

Sunray Hydro 157 Tenth St Mildura VIC 3500 (03) 5023 6422



Supply Net International P/L PO Box 171 Highbury VIC 5089

The Hydroponic Connection Boronia VIC 3155 (03) 9761 0662

Urban Hy 1/59 Gilbert Park Dr Knoxfield VIC 3180 (03) 9764 9400

(08) 264-3600

Valley Hydro and Home Brew 166 Argyle St. Traralgon, VIC 3844 (61) 3 5164 2297

Vic Garden Pty 31B Slater Parade Keilor East VIC 3033 (04) 3160 5025

Waterworks Hydroponics Unit 1, 5 Brand Dr. Thomastown VIC 3074

Westside Hydroponics 202 Main Rd. Ballarat VIC 3350 (03) 5338 7555

#### WESTERN **AUSTRALIA**

Accent Hydroponics Morley WA 6062 (08) 9375 9355

Aqua Post Unit 2B 7 Yampi Way Willetton WA 6155 (08) 9354 2888

Aguaponics WA Lot 12 Warton Rd. Canning Vale WA 6155 (08) 0064 0222

Bloem PO Box 1816 Subiaco WA 6008 (08) 9217 4400

**Bunbury Alternate** Growing Supplies 8/13 Worcestor Bend Davenport WA 6230 (08) 9725 7020

**Creative Grow Store** 1/95 Dixon Rd. Rockingham WA 6168 (08) 9528 1310

**Great Southern Hydroponics** Shop 1, 21 Hennessy Rd. Bunbury WA 6230 (08) 9721 8322

**Greenfingers World of** Hydroponics Maddington Shop 1, 6-8 Emerald Rd. Maddington WA 6109

Greenfingers World of Hydroponics Midvale 22 Flliot St.

Midvale WA 6056 (08) 9274 8388

(08) 9841 3220

(08) 9452 0546

**Greenlite Hydroponics** 4/91 Wanneroo Rd Tuart Hill WA 6060 (08) 9345 5321

**Growsmart Hydroponics** 47768 South Coast Hwy. Albany WA 6330

> 441 Ĥydro Ĥill

Hydro Hill Hydroponics 9/35 Biscayne Way Jandakot WA 6164 (08) 6461 6816 hydrohill.com.au

Hydro Nation 41A Rockingham Rd. Hamilton Hill WA 6163 (08) 9336 7368

**Hydroponic Xpress** 295 Warton Rd. Canning Vale WA 6155 1 800 640 222

Hydroponic Solutions 1/1928 Beach Rd.

Malaga WA 6090 (08) 9248 1901 hydroponicsolutions.com.au

Hydroponic Warehouse Unit 7/627 Wanneroo Rd. Wanneroo WA 6065 (08) 9206 0188

Hydroponica 317 Guildford Rd. Maylands WA 6051 (08) 9371 5757

Isabella's Hydroponics 66 Jambanis R Wanneroo WA 6065 (08) 9306 3028

Johnson's Nursery Garden Centre 30 Blencowe Rd. Geralton WA 6530 (08) 9921 6016

Neerabup Organic & Hydroponic Supplies Unit 1, 21 Warman Neerabup WA 6031 (08) 9404 7155

One Stop Hydroponics 11 B Beechboro Rd, S Bayswater WA 6053 (08) 9471 7000

Perth Hydroponic Centre Shop 4, 171-175 Abernathy Rd. Belmont WA 6104 (08) 9478 1211

Reptile and Grow Store Unit 7 - 117-119 Dixon Rd. Rockingham WA 6168 (08) 9527 2245 rentileandgrow.com

Richo's 4 Hydro Unit 7/22 Franklin Ln. Joondalup WA 6027 (08) 9301 4462

Southwest Hydroponics Lot 29, Pinjarra Rd. Mandurah WA 6210 (08) 9534 8544

The Grow Room 1/1451 Albany Hwy. Cannington WA 6107 (08) 9356 7044

The Great Indoors Unit 1/25 Gillam Dr. Kelmscott WA 6111 (08) 9495 2815

The Watershed Water Systems 150 Russell St. Morley WA 6062 (08) 9473 1473

The Watershed Water Systems 2874 Albany Hwy. Kelmscott WA 6111

The Watershed Water Systems 1/146 Great Eastern Hwy. Midland WA 6210 (08) 9274 3232

Tolesas No. 6 Abbey Rd. Armandale WA 6112 (08) 9497 3527

(08) 9495 1495

tolesasgrowsmart.com.au Tru Bloomin Hydroponics

7/36 Port Kembla Di Bibra Lake WA 6163 (08) 9434 5118 Water Garden Warehouse 14 Drake St Osborne Park WA 6017 (08) 9443 7993

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Easy Grow Manukau 15/69 Wiri Station Rd. Manukau, Auckland (09) 263 7560

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Otaki Hydroponics 1083 S.H. 1 South Otaki (06) 364 2206

House of Hydro 221 Waiwhetu Rd. Lower Hutt, Wellington

Pet and Garden 10 Fitzgerald Ave. Christ church (03) 377 2507

**Grow and Brew** 14a Flexman Pl. Silverdale, Auckland (09) 426 2095

**Hyalite Christchurch** Middleton, 8024 (03) 338 3762

Hyalite Dunedin 313 King Edward St. Dunedin, 9012 (03) 456 1980

Hyalite Hamilton 1C Sunshine Ave. Te Tapa Hamilton (07) 850 8351

**Hyalite Hastings** 406 Eastbourne St Hastings, 4122 (06) 876 7885

Hyalite Henderson Unit 159 Central Park Dr. Henderson (09) 837 1210

**Hvalite Linwood** Linwood (03) 381 0937

Hyalite Manukau ' Cavendish Dr. Manukau (09) 263 4336

**Hyalite Nelson** Nelson (03) 546 4769

Hyalite Tauranga 64 Ninth Ave. Tauranga, 3100 (07) 579 9840

**Hyalite Upper Hutt** 1060 Fergusson Dr. Upper Hutt (04) 526 3913

**Hyalite Wellington** 62 Kaiwharawhara Rd. Wellington (04) 472 5265

Hyalite Whangarei 189 (Lower) Dent St. Whangarei (09) 438 022

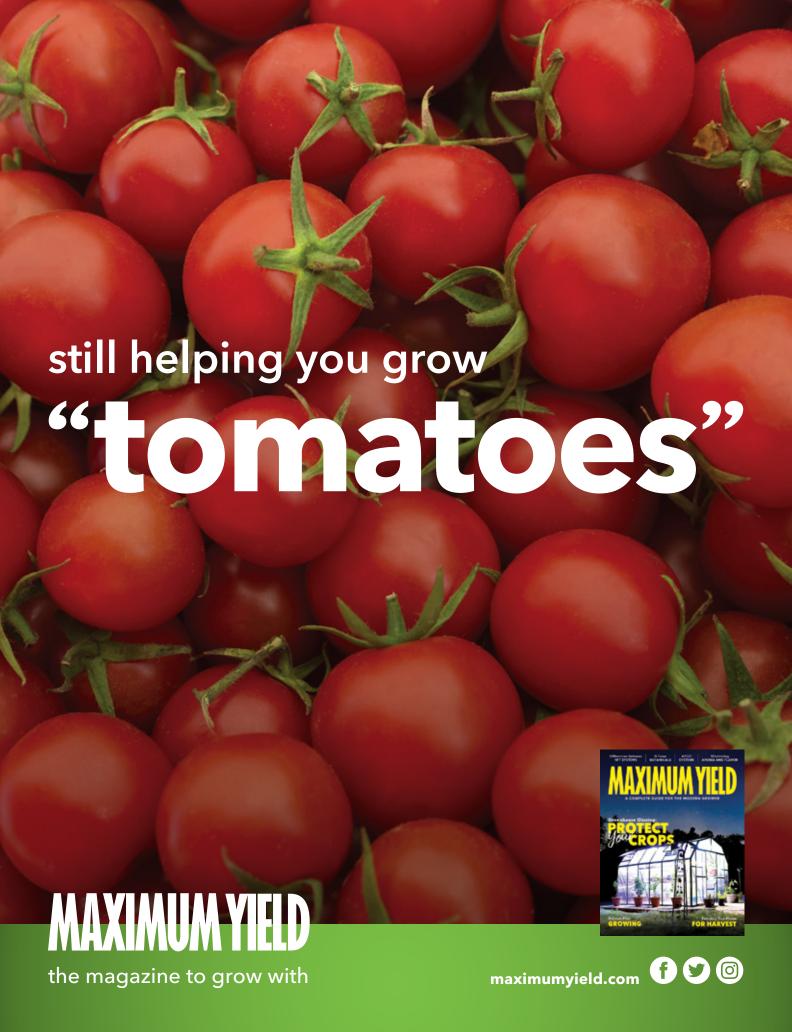
#### INTERESTED IN CARRYING MAXIMUM YIELD IN YOUR STORE?

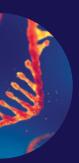
Distribution is available by contacting:

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- House & Garden
- Hydroponic Generations
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Already a distributor?

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# **RIBOSOMES**

by Philip McIntosh

Proteins are the little worker bees of the cellular world. Or maybe they are more like robots. Either way, making them requires ribosomes.

**RIBOSOMES ARE** complex molecules that have one job and one job only – to make proteins to do cell work.

**THE "CENTRAL** dogma of biology" states that DNA leads to Molecular RNA which leads to proteins. Of course, there are exceptions to that rule, but life as we know it is certainly impossible without proteins.

PROTEINS ARE the "worker bees" or "micro-machines" that do all kinds of work inside cells. They are made of chains of amino acids in accordance with a triplet code specified by RNA molecules. There are 20 standard amino acids, each one with its own code of three bases found in RNA, abbreviated A, U, G, and C.

IN EUKARYOTES such as plants, the triplet code in DNA (made of combinations of A, T, C and G) is transcribed in the nucleus into an equivalent messenger RNA (mRNA) code (note that T becomes U in an mRNA molecule). The RNA is exported from the nucleus out to the ribosomes to be translated into protein.

**EACH CELL** has many ribosomes, the number of which depends on the activity of the cell and what its job is. Rapidly dividing cells may have millions of ribosomes at work.

#### **RIBOSOMES THEMSELVES**

are composed of more than 70 individual proteins along with small but very important strands of ribosomal RNA (rRNA).

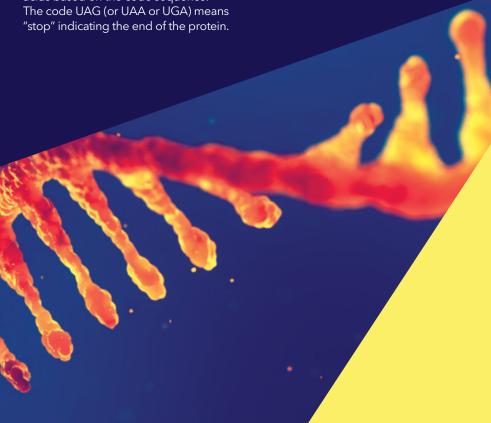
ENTIRE BOOKS have been written about ribosomes and their function but here is the short version: a ribosome latches onto an mRNA molecule and "reads" the code one triplet at a time (eg UUC codes for the amino acid phenylalanine) and synthesises a growing chain of amino acids based on the code sequence. The code UAG (or UAA or UGA) means "stop" indicating the end of the protein

**ONCE COMPLETED,** the protein is released from the ribosome and then folds up into the final shape required to do its job (the function of a protein is based largely on its 3-dimensional shape).

#### **EUKARYOTIC RIBOSOMES**

are not as fast as those found in bacteria but are able to translate at an average rate of about five amino acids per second.

**RIBOSOMES CAN** translate short proteins of a few hundred amino acids in a minute or two. Large proteins may contain tens of thousands of amino acids and take a several hours to complete.



# **GrowLush Lamps**

Recommend to use with high output ballast



