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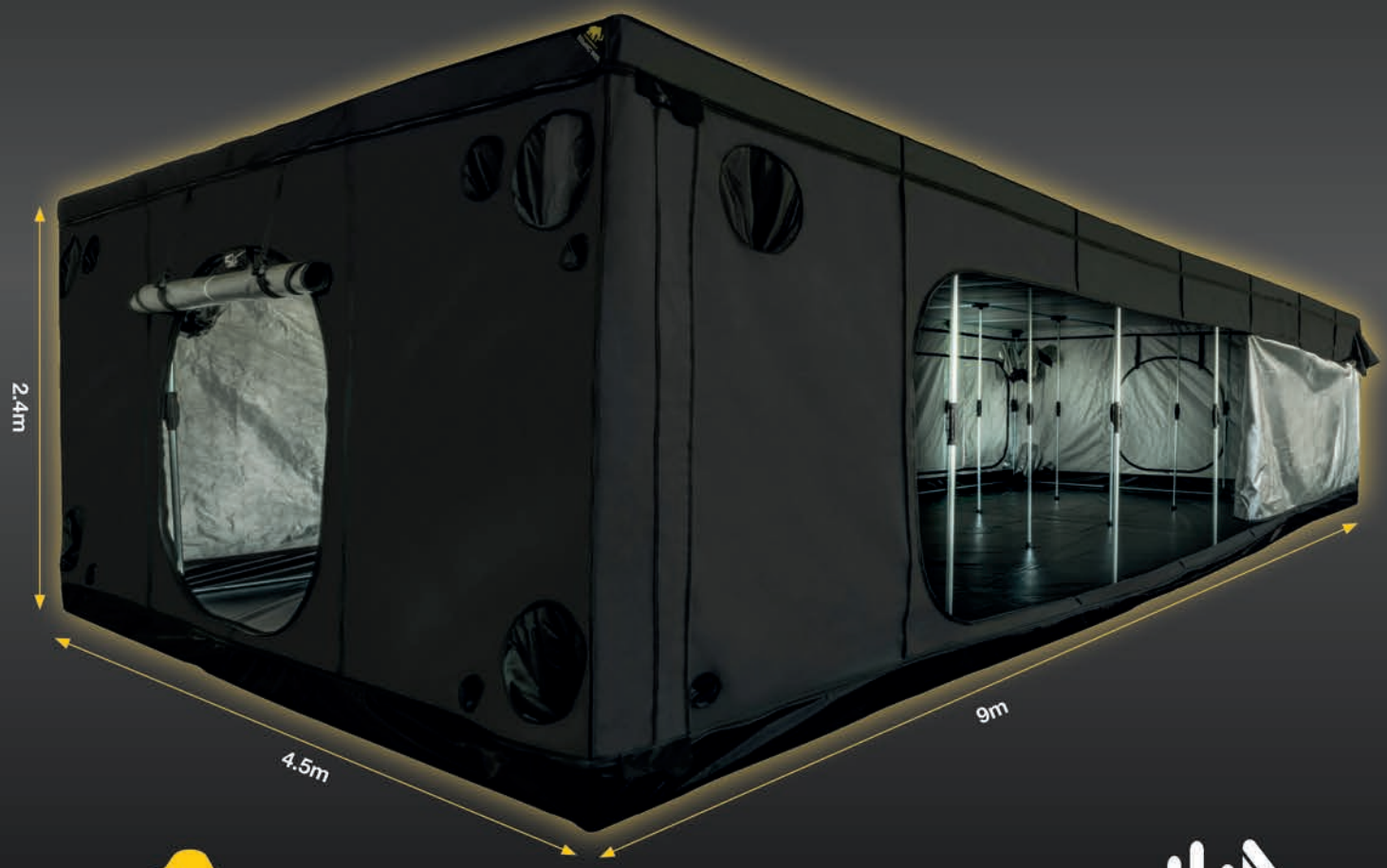

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from the **EDITOR**

TG **Toby Gorman**

Hydroponic, vertical farming, and urban farming at the commercial and hobby levels are making strong gains in popularity virtually everywhere. While cannabis is currently receiving most of the media attention, how we grow and distribute fresh produce is undergoing a quiet revolution.

Because of that, thousands of people interested in growing their own food are searching for information and techniques to get them started or improve upon their current methods. If you are one of those people, we are here to help.

For the past several months, we have been busy loading up our website, *maximumyield.com,* with thousands of articles, products, columns, terms, and anything else a grower needs to have the healthiest, most productive indoor or outdoor garden possible.

Whether you need information on technical aspects such as lighting, irrigation, climate control, or pest control, or want to know more about plant biology, we've got you covered.

For growers on the go, you can also find all the information you need on our new mobile app, available on both Android and iPhone systems.

Of course, there are also those, like myself, who still love the feel of a print magazine in their hands. At home in a favourite chair with the dog at your feet or in the lunchroom at work, magazines continue to be a great source of education and entertainment.

Whether you're on our website, app, or reading a hard copy of *Maximum Yield*, all of the information you need is there to get you growing.

As always, thanks for reading *Maximum Yield* and if you have any questions feel free to contact us at *editor@maximumyield.com.*

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Featured Contributors

Lee G. Lyzit's past experiences within the indoor gardening industry include being a hydroponic retail store manager and owner. Currently, he works as a writer, consultant, and product tester for various indoor horticulture companies. His inquisitive nature keeps him busy seeking new technologies and methods that could help maximise a garden's performance.

Lee Allen is an award-winning reporter of both electronic and print media and a struggling backyard gardener.

Contributors

Grubbycup
Kent Gruetzmacher
Shannon McKee
Dr Lynette Morgan

HEMP

Hemp (*Cannabis Sativa*) is a tall, widely cultivated plant in the Cannabacea family that has a tough bast fibre used especially for cordage. The plant is also commonly used as a source of textile fibre, seed oil, and food.

MAXIMUM YIELD

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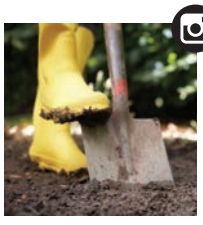
branching **OUT**

Thank you for this helpful edition.

Chokri Hizem *@HizemChokri*
Pre sprouting your seeds is the easiest way to make sure you plant viable seeds and get a jump on the spring growing. It often results in a higher rate of germination since few seeds are lost to environmental factors.

Holland Hydroponics *@hollandhydroponics*
The latest issue of Max Yield has landed, what a cool cover.

VGS Organic *@vgsorganic*
If you love gardening and you aren't following *@maximumyield* you are missing out!



@calinutrientssoil
These (Hugelkulturs) are great to build in winter. I built one last winter using logs and branches that I cut onsite along with garden debris. I topped with our brand of cali compost and I had wonderful yields from my hugelkultur bed last year. It also provides more growing square footage than a traditionally built raised bed. Big green thumbs up to this term of the day!

Stealth Garden @stealthgarden
Great post team, keep up the info sharing!

Article Archives

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

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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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DO YOU HAVE A QUESTION FOR A GROWER? Email *editor@maximumyield.com* to get an answer.

ask a **GROWER**

Q I am an MS holder of entrepreneurship in the field of tourism and I am interested in growing saffron hydroponically as a tourist attraction in a nice village in Qazvin province. Please guide me from the beginning how to start and continue.

I own 500 square metres of land next to a nice river. I already planted saffron corms into the soil and the result is good, so I decided to grow hydroponically.

I really appreciate your help in advance.

Regards, Masoud Saleh

A *Dear Masoud,*

Growing saffron hydroponically is relatively straightforward; however, the type of system you set up depends on whether you simply want to use hydroponics to flower and harvest from the corms or if you want to propagate and generate new corms as well. Below is an explanation of the different ways in which the corms may be grown hydroponically.

There are two ways of running a saffron system. First, the dormant corms can be purchased, usually towards the end of summer or in early autumn, planted, flowered, harvested, and discarded, all over a six-week period. Or, second, after the short flowering period, the bulbs can be grown on, producing vegetation and new daughter cormlets over a period of many months until they become dormant in mid-summer. In the first system, the corms are planted at a high density since they won't be grown on and multiplied. The second system needs more space for the plants to fully develop and many months of caring for the corms after they flower, though the reward is a supply of new corms that could be sold or given away to others and a higher yield of flowers in the next year. Tying up a hydroponic system with vegetative saffron for nine to 10 months, however, may not be attractive to those with limited space (though trays of saffron plants are cold hardy and can be put outside for winter and spring if necessary).

Corms can be stored in a dry place and planted out when the hydroponic system is ready. The spacing should be approximately10-13 centimetres apart and four to five centimetres deep, in a tray filled with a sterile, free-draining growing medium, such as coconut fibre with some perlite mixed in. The medium needs to support the plants, yet be friable enough for the young corms to form without deformities, so any substrate used for baby root crops would be suitable.

The flowers will have already been initiated in the corms during the summer dormancy period, and flowering will occur when moisture is provided and temperatures start to drop in the fall (flowering is triggered by environmental conditions such as temperature and moisture). The ideal conditions during flowering are a 16-hour day length with day temperatures of 17˚C and night temperatures of 12˚C. Growing in a greenhouse means the flowers are protected from rain, moisture, and wind, and the lack of weeds makes harvesting high-quality flowers much easier.

Flowering of the corms will typically occur quite quickly after planting; the first emerging flower buds should be seen within a few weeks. The flowers will fully open within three to five days and be ready for harvest. As each flower blooms, it should be plucked or snipped from the plant and taken away for processing. The easiest way of removing the saffron stigmas from the centre of the flower is to pull back and remove all the petals and then snip the golden strands at the base. These will then need to be dried before storage.

Good luck with your saffron crops.

Kind regards,
Dr. Lynette Morgan

LM **Dr Lynette Morgan** holds a B. Hort. Tech. degree and a PhD in hydroponic greenhouse production from Massey University, New Zealand.

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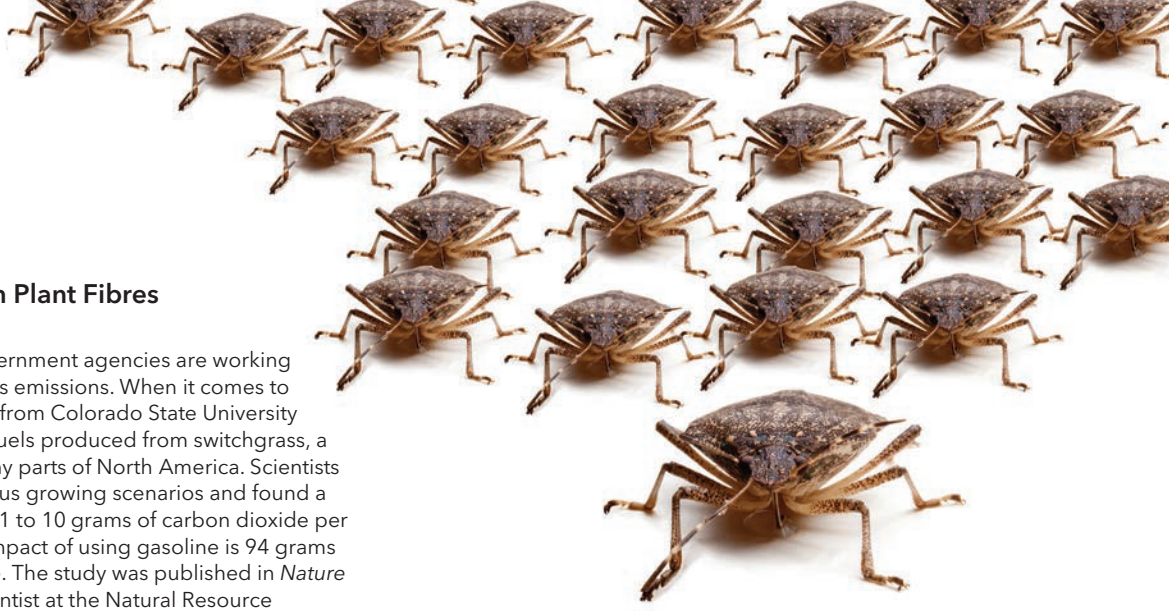


Using Biofuels Made From Plant Fibres to Battle Climate Change

Scientists, corporations, and government agencies are working hard to decrease greenhouse gas emissions. When it comes to fighting global warming, a study from Colorado State University (CSU) finds new promise for biofuels produced from switchgrass, a non-edible grass growing in many parts of North America. Scientists used modelling to simulate various growing scenarios and found a climate footprint ranging from -11 to 10 grams of carbon dioxide per megajoule. In comparison, the impact of using gasoline is 94 grams of carbon dioxide per megajoule. The study was published in *Nature Energy*. John Field, research scientist at the Natural Resource Ecology Lab at CSU, noted what the team found is huge. "What we saw with switchgrass is that you're actually storing carbon in the soil," he says. "You're building up organic matter and sequestering carbon." His research team works on second-generation cellulosic biofuels made from non-edible plant material such as grasses.

–eurekalert.org

Greenlandic Mud Could Help Feed the World

All mud is not created equal. In fact, the grey mud in Greenland flowing off the melting glaciers is rich with nutrients like quartz, feldspar, and mica. The minerals get crushed to a fine powder. The rocks are ground to incredibly fine flour, known as glacier flour. The tiny grains give this flour an incredibly large surface area, which can react with water, roots, and microorganisms in the soil. So, what if we take this nutrient-rich glacier flour from the Arctic and transport it to the tropics where soil is poor for crop growing? The glacial flour could be quickly activated and release its nutrients to the soil and plants, giving a huge boost to the poor tropical soil. Greenland would benefit financially from a new, sustainable industry while benefitting tropical countries with better crop growing conditions. Trials are ongoing, and the mud will soon be tested in Brazil.

–sciencenordic.com

Norwegian Doomsday Seed Vault Gets Massive Upgrade

Ten years after building a concrete vault to safeguard 900,000 of the world's seed samples, the Norwegian government is doling out $12.7 million to upgrade the facility. The Svalbard Global Seed Vault was built to safeguard the world's food supply in case of war, climate change, or natural disaster. The vault is basically a thumb drive for the world's crops. It provides a potential backup for countries whose crop supplies are down and gives them a way to rebuild what's been lost or destroyed. The money from the Norwegian government will go towards building a concrete access tunnel as well as a service building to house emergency power and refrigeration units. Other electrical equipment will also be installed. Recent indications show even this well-built vault may not be immune to the ebbs and flows of the world's climate, as it was built a decade ago. In October 2016, the area surrounding the seed vault was subject to temperatures so unseasonably high that the permafrost around the vault melted, leading to flooding inside.

–munchies.vice.com

Stink Bug Scare in Perth Warehouse

The Australian Department of Agriculture and Water Resources (DAWR) had a huge scare when stink bugs were found in a southern suburb of Perth, Western Australia. The DAWR reported both live and dead brown marmorated stink bugs were found within a shipment of imported cargo from Italy that wound up in a warehouse located in Jandakot. The DAWR quickly took biosecurity actions at the site, including spraying and surveillance, and further biosecurity could be called for pending the results of surveillance activities on the warehouse. "Australia has strict import conditions, as well as measures offshore, at the border, and onshore to manage biosecurity risks. Established response plans are also in place to effectively manage biosecurity pest detections," says a DAWR representative in a statement. The stink bug is an invasive pest that attacks tree fruits, berries, grapes, vegetables, corn, and ornamental plants. If unchecked, they can take out entire crops and plantations.

–freshfruitportal.com

Rice Nitrate Transporter Increases Grain Yields

A recent study has identified a rice nitrate transporter that can be overexpressed to increase grain yield and accelerate flowering. This new approach should improve grain yields while avoiding the downside of late maturation in rice. Nitrogen fertilisers (applied as nitrate or ammonium) improve the amount of grain produced per acre, but nitrogen runoff and volatilisation pollute water and the air. In grains such as rice, large amounts of nitrogen fertiliser can delay flowering, leaving the crop vulnerable to late-season cold weather. Now, recent work in the key staple crop rice (*Oryza sativa*) identified a nitrate transporter (OsNRT1.1A) that may provide a solution to the nitrogen use/flowering problem. In the plant, different transporters move nitrogen from the soil into the roots and move nitrogen compounds throughout the plant. Some transporters sense nitrogen levels and trigger responses. The study, by Wang et al., published in *The Plant Cell*, showed rice OsNRT1.1A can affect both nitrogen use and flowering time.

–sciencedaily.com

German Cities Transformed Into Organic Gardens

With more and more people living in urban centres, food security and quality is a huge issue. In Germany, the world's 17th most populated country, cities are going to a hyperlocal level when it comes to producing organics. For example, in Nuremberg, every first-grader begins the year with a gift: a yellow plastic lunchbox filled with healthy food that is refilled every day. It's part of a city movement to increase the share of local, organic food in public institutions. As part of *Biostädte*, or "organic cities," Nuremberg belongs to a network of municipalities across Germany—including Munich, Bremen, and Karlsruhe—that is working to make food production healthier and more sustainable. In other cities like Berlin, Cologne, and Kiel, similar food councils are introducing urban and community-supported agriculture, which includes the greening of new buildings and transforming uncontaminated industrial land into community gardens. Their plans also include projects for car-free, solar-powered districts where edible plants grow on and around buildings.

–dw.com

Spectrum King 402 LED Grow Light

Newly arrived in Australia, the Spectrum King 402 light emitting diode (LED) grow light covers a 1.2x1.2-metre area for flower and up to 1.5x1.5 metres for vegetative stage plants. It is unrivalled in terms of growth for the 460W of power it draws. Guaranteed to lower the overall ambient room temperature compared to the equivalent high intensity discharge light—a single-ended 1,000W high pressure sodium. The unit has no moving parts like cooling fans and it can be dimmed to suit the plants' stage of growth. Safety certified and IP65-rated with water-resistant housing, the SK402 is perfect for wet and humid environments. High-performance Cree LED chips are part of the secret to the SK402's success and the white spectrum provides a much higher output than other multicoloured LEDs. Join the rising number of growers saving power and growing through the Aussie summer.

Bio Diesel Rhino K

Rhino K is a strong potassium (K) bloom booster that promotes more flowering sites with denser development and heavier blooms. Rhino K contains no phosphorus (P) and is more microbe friendly than most P-K bloom additives. With a pure, 15 per cent K solution, the product should be employed during the last three weeks of budding to harden and swell flowers during the demanding later bloom stages. Fulvates maximise key nutrient movement and sugar transfer, directing all energy and plant reserves towards bud formation, enhanced trichrome, and increased oil production. It also improves terpene production. Rhino K is formulated so it doesn't leave any harsh residues, while producing a clean, full harvest without heavy metals or harsh chemicals.

Hydroponic Generations SEA ESSENTIALS

An excellent additive, SEA ESSENTIALS is a balanced formulation that encourages flower production and increases root biomass. It is a specially formulated blend of several sea plants, each with its own unique health-promoting properties and benefits. Sea plants are highly regarded for their amino acid and natural stimulant content. Theses naturally occurring compounds help promote flowering, nutrient uptake, and support a healthy rhizosphere while encouraging beneficial microbes. SEA ESSENTIALS also provides plants with a natural source of potassium, amino acids, and trace elements for improved flower quality and higher resin production. Naturally occurring nitrogen is essential for amino acid synthesis and terpene production during early and later flowering. This product will give your plants better health through all stages of growth and flower development and should be used from when flowers start forming through to final harvest.

TECO Hydroponic Chiller

The TECO line of Italian-made hydroponic water chillers are durable, reliable solutions for hydroponic gardeners. Maintaining correct water temperature is essential for oxygen and fertiliser uptake in root systems. The right temperature also helps reduce fungal diseases in hydro growrooms. The TECO range of hydroponic chillers are built to accurately and easily keep your reservoir or hydroponic system within acceptable water temperature parameters. The tough Italian design uses minimal power consumption and the settings and functions are easy to figure out. TECO Hydroponic Chillers are currently available in four sizes from 150-2,000 litres. The exclusive use of internationally-recognised, high-performance compressors ensures peak performance. From design to production, these hydroponic chillers have been built with the aim of ensuring reliable quality for the grower.

Current Culture UC Solo Pro 35

Current Culture is a California-based hydroponic system manufacturer with more than 30 years of refined engineering for premium performance and longevity of heavy-flowering harvests. The UC Solo Pro 35 is a perfect 115-litre (30-gallon) deep water culture (DWC) hydroponic system. High levels of aeration optimise plants' nutrient uptake, promoting faster growth. The Solo Pro allows growers to cultivate extremely large cultivars with limitless root growth potential. Current Culture kits include everything needed to get started—all you need to add are plants and water. These unique kits include a robust air pump and all required fittings and fixtures for ultimate simplicity. Current Culture has Sthe most finished and optimised undercurrent and DWC systems available in the global market, designed for practical use and serious durability.

Spectrum King LED Grow Lights

Spectrum King light emitting diode (LED) grow lights are now available in Australia. From the Closet Case 140W, which replaces 315W ceramic metal halide and 400W high pressure sodium grow lights, through to the dimmable SK602, the world's leading indoor grow light. They boast a unique light spectrum that mimics the sun and are perfect for veg and flower phases. Make your money back with savings on power use and grow throughout the summer heat. You can even use these fixtures outdoors. The range of Spectrum King LEDs is fanless, rated to IP65 water resistance, and they have a five-year warranty. Spectrum King offers a three-year warranty on light output too—something never before offered by an LED light manufacturer. Check out the Mothers Little Helper for vegetative phase and the Closet Case for veg and flower.

Hydroponic Generations HUMIBOOSTA

This fast-working additive assists in maintaining health in the rhizosphere while encouraging beneficial microbes, especially when cultivating in cocopeat, soil, and hydroponic systems. Humic and fulvic acids are known for their ability to bind nutrients, making them more easily absorbed. HUMIBOOSTA is suitable for all grow systems and can be used through all stages of growth, flower, and fruit development. HUMIBOOSTA is also an organic source of additional potassium and magnesium, which support healthy vegetative growth. Magnesium plays a key role in photosynthesis since it is an essential building block for chlorophyll production during photosynthesis. Another benefit is the addition of soluble calcium, which is essential during the late-growth stage to ensure a high number of flowers are produced and retained by the plant. A lack of calcium can lead to flowers aborting before they can transition into the fruiting stage.

Bio Diesel Marine CaMg+

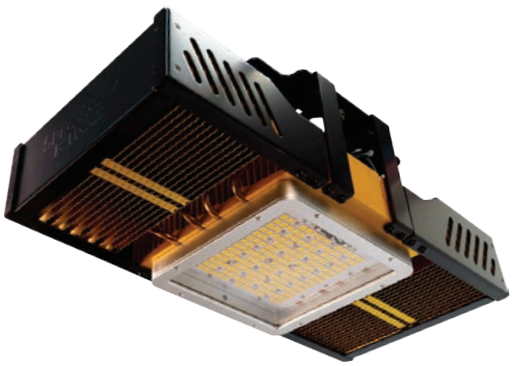
An amazing growth enhancer, Marine CaMg+ is designed specifically for medical cultivation. With naturally derived ingredients from the sea, including crustacean-derived chitin for high levels of natural micronized calcium and trace elements. Marine CaMg+ also provides fast-acting nitrogen and 100 per cent natural growth stimulants from the sea for faster, lush growth and much larger, heavy-yielding branches. This product encourages plant cell division and growth rates, while promoting increased tolerance to stress and insects. Marine CaMg+ contains natural growth regulators for faster growth rates and can quickly correct nutrient deficiencies of calcium, magnesium, or nitrogen in as little as 24-48 hours. Available in one- and five-litre sizes.

Bio Diesel Green Diamond

Another excellent Bio Diesel product, Green Diamond is a two-part base that's specially designed for hydroponic and coco fibre grow environments. It's a complete base that's rich in all micro and macro nutrients required for fast growth and flowering. What makes Green Diamond work so well is it's packed with natural chelates and organic plant metabolites, along with pure minerals of the highest quality. Bio Diesel has also added additional trace elements, B vitamins, fulvic acid, and other bio stimulants that work exceptionally well in hydroponic and coco fibre media. Unlike other two-part base nutrients on the market, Green Diamond boasts a bio mineral suspension that includes organic metabolites, fulvic and humic acid as well as a mix of vitamins that enable faster growth.

Sunmaster SUPER 1,000W Base Up Metal Halide Lamp

Sunmaster's SUPER 1,000W base up metal halide lamps provide the ideal single-lamp source for practically all phases of plant growth, emitting a balanced 4,000 K from a light source that imitates the natural white look of sunlight. Effective in promoting both vegetative growth and flowering, this Sunmaster lamp surpasses many other high intensity discharge sources in photosynthetic active radiation (PAR) watts, the most objective measurement of total light energy available for photosynthesis. The Sunmaster SUPER features a balanced spectral output and offers a long operational life at a very competitive price. Sunmaster continues to set new standards in general plant lighting and promoting high levels of photosynthesis without compromise.



Spectrum King 602 LED Grow Light

The Spectrum King 602 light emitting diode (LED) grow light is at the top of the mountain when it comes to horticultural lighting. With a massive 1.5x1.5-metre coverage for flowering plants and using the highest quality Cree LEDs, there is now a fixture that replaces and outperforms 1,000W dual-ended high intensity discharge bulbs. Expect power savings, less heat, and a fixture requiring no maintenance or change of bulbs, all with a five-year warranty. The Australian model is supplied with a dimmer to adjust for small plants and reduce power consumption to 10 per cent of the original 640W draw. This is the brightest LED fixture on the market with a light output guarantee of three years. It will perform at 90 per cent or better after three years or receive a replacement. This light is rugged and designed for wet, humid growing environments.

Bio Diesel Aloevate

A 100 per cent natural plant tonic containing hundreds of vitamins, minerals, and enzymes, Aloevate is made from blended desert plant extracts. It contains natural salicylic acid (silica), auxins, amino acids, saponins, and enzymes that enhance micro-life, protect your root zone, and break down any dead roots and unused mineral salts to keep the plant roots clean and functioning at peak performance with healthy microbe colonisation. Aloevate improves your plants' size, vitality, and overall growth rates while protecting them from disease. Plants become stronger with thicker cell walls and a higher water-holding capacity. Aloevate is also an amazing foliar spray; it creates thicker, stronger cell walls and activates the plants' systemic required resistance response to deter pests and disease. It can also be added to any other foliar spray as a natural wetting agent and chelating agent to aid in mineral transportation. Available in one-, five-, and 20-litre sizes.

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In 1938, *Popular Mechanics* declared hemp the "new billion-dollar crop." That announcement came a little late, however. Though hemp had been used around the globe for thousands of years, the stigma associated with marijuana (hemp's cousin) put an end to a majority of hemp production. Fortunately, that stigma is starting to change, and we are seeing more hemp-based products as a result. **by Lee G. Lyzit**

HEMP REVIVAL

Humans and hemp go way back. Historians at the Massachuetts Institue of Technology theorize that the plant was the earliest crop cultivated for textile fibre. They also think hemp was the first example of human industry. Archeologists found scraps of hemp cloth in Mesopotamia (modern-day Iran and Iraq) that date to 8,000 BC, as well as evidence of hemp cord in Taiwan from the same time. In approximately 150 BC, the Chinese—who have the longest documented history of hemp cultivation at 6,000 years—discovered how to transform the plant into paper. By the middle ages, hemp was an extremely valuable source of food and fibre around the world. It also became indispensable in the production of sailing canvas, rope, and oakum. The UK's King Henry VIII even passed a law in 1535 requiring farmers to grow the plant or be fined. Similar laws passed in colonial America in 1619, 1631, and 1632.

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> **Structures built** with hemp products are carbon sinks, meaning they absorb more carbon than they release."

Hemp's reign, however, began to crumble in the 18th century. First came cotton and the cotton gin, which made processing that plant much easier than producing hemp fibre. Then, in the 1930s, competition in the synthetic textile and wood-based newspaper print industries petitioned the US government to impose prohibitive taxes on hemp producers, which it did. It was also around this time—and possibly thanks to these lobbying competitors—that hemp's lasting association with marijuana also took hold. Soon after, the Marihuana Tax Act of 1937 banned hemp production in US. Other countries followed suit around the same time.

Today, less than 100 years later, hemp is seeing a resurgence around the world. Some of the biggest potential modern uses for the plants are as sustainable building products. These can replace or supplement a wide variety of traditional materials, including wood and concrete. Hemp particle board is made of fibres from both the inner and outer portions of the hemp stalk. The outer fibres are also used to create building insulation. Then there is hempcrete, a bio-composite made of hemp cores and lime. It can be used in block form in conjunction with wood-frame construction or mixed directly into a structure, like stucco or cob. Hempcrete is comparable in strength to traditional concrete but weighs one-eighth as much. The low-maintenance material also has thermal regulating properties, is naturally mold and rodent resistant, has a long lifespan, and is easy to repair. Building with renewable, biodegradable materials like these equates to a healthier planet. Not only do hemp plants turn carbon dioxide into oxygen while they grow, but structures built with hemp products are carbon sinks, meaning they absorb more carbon than they release. Traditional concrete, on the other hand, is notorious for releasing large amounts of carbon dioxide when it is made.

Another incredible modern use of hemp is in the automotive industry. Do you remember Henry Ford's hemp car? Due to the steel rationing of WWII in 1941, Ford and George Washington Carver constructed a car body made of soybeans and hemp. Although this car never took off, today's automakers are paying closer attention to hemp, as it can be used to make plastics and other composites that are stronger and lighter than their traditional counterparts. In fact, Canadian company Motive Industries used the material to build the entire body of the world's most eco-friendly car, the Kestrel. Hemp is also used to create bioethanol and biodiesel.

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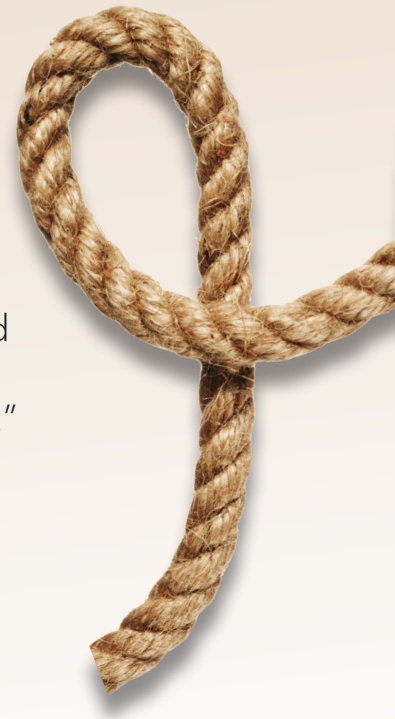
These fuels are reportedly more environmentally friendly to produce than those made from sugar beet, palm oil, and corn. Not only is hemp easier and faster to grow than many other plants in a variety of climates, but it leaves the ground in better condition than when it was planted. It also has a 97 per cent conversion efficiency, as reported by graduate student researchers at the University of Connecticut.

Traditional hemp uses are also seeing a comeback, and consumers can once again buy hemp clothing, paper, bags, jewelry, and ropes. Even traditionally plastic items like sunglasses and molded chairs are now made of hemp. Other uses include water and soil purification, animal bedding, and horticultural mulch. Due to its high levels of beneficial oils and natural emollient properties, the plant is also commonly used to make beauty products, suntan lotion, and cosmetics. Hemp oil can be used as a natural wood sealant as well.

Then, there is food. Hemp oil, protein powder, and alternatives for milk and nut butter products are all found on grocery store shelves in many countries. Even more popular are hemp seeds. Hemp seeds contain all the essential amino acids humans need and are arguably one of the most healthy food sources on the planet. Three tablespoons of hemp seeds have about 10 grams of protein, three grams of carbs, and 14 grams of fats. About 12 grams of those fats are omega-3 and omega-6. Hemp also contains stearidonic acid and the rare omega-6 gamma linolenic acid,



> “**Hemp seeds** contain all the essential amino acids humans need and are arguably one of the most healthy food sources on the planet.”

which has been shown to help with cholesterol, inflammation, skin and hair health, balancing hormones, and general heart health. It also contains magnesium, fibre, iron, zinc, and phosphorus. Hemp is also a good source of nutrition for animals, and some veterinarians recommend feeding it to pets and livestock. In Europe, fishermen sprinkle hempseed on the water as an effective bait.

Humans are at a point where practicing a sustainable lifestyle is of the utmost importance. Just as the hemp plant was an intricate part of early man’s existence, it may very well become an intricate part in ours, as more people start to embrace how versatile it really is.

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Hydroponics & MYCOLOGY

A Fascination with Fungi

by Lee Allen

Mushrooms check a lot of boxes for the future of food. Quintessential decomposers, these organisms assist in plant growth, are packed with protein, are easy to grow, and are just downright tasty. Lee Allen sat down with fungi guru Barry Pryor to learn more about our future with fungi.


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There's both myth and magic about mycology that plant pathologist Dr. Barry Pryor finds fascinating. "One of the most dramatic impacts of fungi on plants comes from a specific group, a particular phylum that has its own trajectory in the tree of life," says Pryor. "Some of the first records of fungi associated with plants come from fossilised endomycorrhizal fungi whose spores have been found in fossil records dating back 500 million years."

That symbiotic relationship between fungi and plants with root systems benefits both organisms. "Fungi interact with plants at almost all stages of growth—from seed germination to plant maturity to plant disease to a decay of dead plants that recycle nutrients available for the next generation of plants."

Pryor's interest in plants has led him down the path of spore science and he's become somewhat of a mushroom guru. As a university professor, one of his more popular courses is Mushrooms, Molds, and Man.

"All mushrooms are fungi, but not all fungi produce mushrooms," he clarifies. "Probably 90 per cent of fungi don't produce mushrooms, which are the fruiting bodies of some species—much like the apple is the fruiting body of a tree."

> **Fungi interact** with plants at almost all stages of growth–from seed germination to plant maturity to plant disease to a decay of dead plants that recycle nutrients available for the next generation of plants."

From a consumer standpoint, according to the American Mushroom Institute, recent annual US mushroom sales posted a US$1.2-billion value based on the consumer purchase of nearly 430 million kilograms of the tasty morsels.

Mushrooms represent one of the fastest growing specialty crops worldwide, a growth driven by increased demand for locally grown product as part of a healthy diet, says Pryor, the driving force behind the fledgling Arizona Mushroom Growers Association.

The American Mushroom Council estimates consumption at 1.8 kilograms of product per person, per year. "Historically, since 1850, mushroom production [in the US] has been concentrated in Pennsylvania, specifically Chester County, as producers of durable field mushrooms like the white button, crimini, and portabello grown in open beds," says Pryor. "These mushrooms travel well and have a shelf life of three weeks or so, unlike specialty mushrooms like oysters, shiitakes, lion's mane, and others that begin to degenerate within a week. So, there's a demand for local production of specialty mushrooms grown in controlled environments."

That's where his association, in concert with researchers at the University of Arizona Controlled Environment Agriculture Center and the MycoCats come into play. "There's no incongruency growing mushrooms in the desert; all you have to do is control the environment. If Pennsylvania can grow mushrooms in the winter, we can grow them in the summer and year round."

Currently, the MycoCat organisation is conducting industry research. It is seeking to find innovative methods of completing the cycle of sustainability by studying ways to grow fungi in substrate made of a variety of recycled agricultural and post-consumer waste products.

While straw or wheat is a traditional substrate for mushroom spores, mesquite bean pods and cotton seed have proven to be a successful growing medium, as have used, greasy, ground-up pizza boxes that provide an additional food source for the mushrooms.

"We take things that would normally go into a waste stream landfill—like food waste, landscape debris, old textiles—and extract value-added product. Mushroom-forming fungi breaks them down into a substrate that we use to extract an edible product from, then let the substrate continue on its trajectory through the recycling stream. It's amazing what fungi can do," says Pryor.

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> **Mushrooms represent** one of the fastest growing specialty crops worldwide, a growth driven by increased demand for locally grown product as part of a healthy diet."

Take the pizza boxes, which contain fats, oils, and meat and cheese residue. "They're not suitable for adding directly to a compost pile because they would change the microbial community. But fungi break things down to a condition where they're suitable to compost. In a sense, it's sort of like pre-composting a product before it hits the actual compost pile.

"Mushrooms are the quintessential decomposers of the planet, turning almost anything into a form that can be readily utilised by other systems," says Pryor.

One of his research projects involves taking spent substrate to make compost teas to add to plants in hydroponic or greenhouse systems that will provide plant nutrition and increase plant health by stimulating the plants defence responses.

Another idea under study is taking used substrate and packing it into long tubes like the straw berm bumpers found on road cuts to contain erosion. Using that same process, the tubes packed with substrate are laid in front of areas where dirty water moves into watersheds. That water would then filter through the berms, which would bioremediate some of the wastewater pollutants like insecticides, pesticides, and petroleum products.

"We also use the spent substrate to feed insects, taking things insects wouldn't normally eat and converting them into a fungus-degraded substrate combination that insects can now utilise. Then, we can use the insects for protein sources for animal feed or perhaps for human consumption."

Pryor says the protein content issue is significant, as is the ability of these miniature pharmaceutical factories to provide micronutrients and vitamins. "They're 40 per cent dry weight protein," says Pryor. "They contain all nine essential amino acids, are high in B and D2 vitamins, and have a higher digestibility index."

Calling mushrooms "the protein source we should send into space," he notes: "We can grow protein in a lot of different sources, but mushrooms have an advantage because of their pharmaceutical properties—antioxidants, antitumor, anti-inflammatory—all the medicinal properties that make them superior. You can't just discount that. If we're going to send astronauts into space, millions and millions of miles away from home, and say, 'Here's your protein source,' we're going to have to have some value added, and mushrooms provide that."

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> **Fungi** break things down to a condition where they're suitable to compost. In a sense, it's sort of like pre-composting a product before it hits the actual compost pile."

There are other advantages. "Animals in space are complex, less precise, less predictable, and take up a lot of room. With plants in a spaceship, you have to generate energy to create light for photosynthesis. But you don't need that with mushrooms—just an LED bulb and you can create protein in a culture that has only one living thing in it."

In another futuristic move, Pryor and colleagues are developing automated growing and harvesting systems to be fitted into interplanetary space vehicles. And it goes beyond even that. "Once these modular food systems have been developed, they can be put anywhere—in deserts, in the middle of a prairie, on ocean islands, we can even put them underwater off the continental shelf—another example of where developments in the space program have spun off potential for all kinds of improvements for life across the planet. Lunar greenhouses with mushrooms can be put in Antarctica, on Mount Everest, or sunk down into the oceans because the continental shelf is an untapped resource."

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TESTING

a New Nutrient Line

by Grubbycup

Nutrients are one of the most important variables in growing a successful crop. But with so many nutrient lines to choose from, how does a grower know which one is best for them? A simple controlled test, as explained here by Grubbycup, could hold the answer.

There are many quality nutrient choices on today's market, and a few controlled experiments can give valuable information about which perform better during a harvest. Common indicators of improvement are increases in production, cost savings, or quality.

Although a larger sample is more accurate, the minimum number of plants needed for such experiments is two. One is the control plant, which is fed the current nutrient regimen, and one is fed with the new feeding schedule. Other than the different nutrients, the plants should be as similar to each other as possible and grown under exact, if not very similar, conditions. Cuttings (clones) are commonly used to minimise the impact of genetic differences.

If using more than two plants, the percentage of the crop to commit to the new feeding schedule is dependent on the confidence the grower has that the change will improve (or at least not hinder) production versus the proven schedule currently in use.

KEEP GOOD RECORDS

Keeping good records improves accuracy. Note the experiment's start date because it will allow for the calculation of daily production after harvest. For the control group, feed as normal and track the amount of each nutrient used. For the experimental group, follow the manufacturer's recommendations and again keep track of the amounts used.


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At harvest, make note of the harvest date, record the harvest weight from each plant, and calculate the totals of each nutrient used. Production improvements are indicated by an increase in the average amount produced per day for the duration.

Subtracting the start date from the harvest date will give the total number of days for the garden. For example, a harvest on Jan. 1 minus a planting date of Oct. 23 would be 70 days. If one group matures faster than the other, calculate each set of dates separately.

Then, divide the amount harvested from each plant by the number of days it took to grow them to calculate the grams per day (GPD) produced. For example, a plant that harvested 35 grams after a 70-day season produced an average of 0.5 GPD. A plant that harvested 30 grams after a 60-day season also produced 0.5 GPD, so this method allows for the comparison of harvests from the lengths of different seasons.

If the only concern is to maximise production, then simply compare the average GPD of the control group versus the average of the experimental group. Whichever method results in a higher GPD is more productive (within a margin of error). If the control group produced an average of 0.5 GPD and the experimental group produced an average of 0.75 GPD, the experimental group would have been more productive.

OTHER FACTORS TO CONSIDER

If expense is a concern, it can be factored in as well. Dividing the total cost of the nutrients used by the total number of days will give an average cost per day. If a gardener spends $140 over a 70-day grow, then they are spending $2 a day on nutrients. Dividing that number by the number of plants gives the amount spent on each plant per day. If an average of $2 a day on nutrients is spent to feed 20 plants, then each plant costs an average of 10 cents a day in nutrients.

> “PRODUCTION improvements are indicated by an increase in the average amount produced per day for the duration.”

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> “AN INCREASE in the daily cost of nutrients should be at least matched with an increase in production to be cost-effective.”

Comparing the GPD and the cost of nutrients can give a clearer picture of the expense versus the return. An increase in the daily cost of nutrients should be at least matched with an increase in production to be cost-effective. Which is to say, any increase in price should be covered by enough additional harvest to offset the difference in cost.

Other improvements, such as the quality of flavour, may be less tangible and more subjective. Blind testing can help minimise bias when judging differences. To set up a blind test, start with an identical container for each sample. Have an assistant who won't be involved with the evaluation prepare the samples. Have them write the identity of the sample on a small piece of paper, then fold the paper so it can't be read and tape it to the bottom of the lid. Then, have them place the sample in the container and close it, and then repeat the process for each of the other samples. They should rearrange the sealed containers (which should appear very similar to each other) randomly and number each of the containers on the outside.

If done correctly, each container will have a name on a folded piece of paper taped to the bottom that matches the sample inside the container that is labelled with a randomly assigned number.

Then, each person judging evaluates each sample, and records results according to the number listed on the outside of the containers. Once all the samples have been rated, their identity can be determined. If one method or the other is substantially superior, it should be reflected in the results.

Calculations and testing can supply empirical evidence to suggest one method over another, but they aren't the only considerations. Other factors may include a gardener's feelings about the manufacturer, availability in the local area, the advice of other gardeners, and sustainability of production methods.

There are many fine nutrient lines available that perform well, and using experimentation and testing can help a gardener decide which is better for them.


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The Science of Serenading Your Plants

by Chris Bond | People sing to their plants—but does it work? Chris Bond separates the fact from fiction in this matter by looking at the science.

"Music hath charms to soothe the savage beast," according to the 18th century playwright William Congreve, but what about its ability to charm a mild-mannered plant? Anecdotally, this phenomenon had been postulated for many years. Over the past five decades, however, numerous research studies have been undertaken to find the answer.

What was found is that, yes, sound affects plants. In fact, plants that are exposed to different types of noise react or grow differently than those that are not. Plants, of course, do not have ears, but they can feel the sound vibrations. Also, they react to different types of music in both positive and negative ways. So, though their taste in music might differ from yours, you might want to find a radio station that they agree with if you are looking to get the most out of your plants.

Types of Music and Their Effect

Different types of music produce a wide range of different results in plants. A 2014 study published in the *International Journal of Environmental Science and Development* looked at the effects five different types of music had on the growth of 30 different pots of a singular rose species. The music genres for this study were Indian classical music, Vedic chants, Western classical music, and rock music. (The researchers were Indian, so they chose some types of music indigenous to their region and included others that were not.) The fifth group, the control group, was not exposed to any music.

The researchers observed and measured several aspects of plant growth over a 60-day period. They looked at shoot elongation (length of branches), internode elongation (distance between branches on the main stem), and the abundance and size of the flowers. Their observations were as follows:

> **"WITH VERY LITTLE** exception, the plants exposed to the classical music outgrew and outyielded those exposed to jazz or those that grew in silence."

- **THE PLANTS** exposed to Vedic chants experienced the most amount of growth at 7.83 centimetres (cm), though those exposed to Indian classical music were close behind at 7.33 cm. Western classical music, silence, and rock music trailed behind with the average growth measured at 5.25 cm, 4.83 cm, and 3.67 cm, respectively.
- **THE AVERAGE** length of internodal elongation was highest with the Indian classical and Vedic chants, with lengths of 4.0 cm and 3.83 cm, respectively. Interestingly, the plants exposed to silence were next longest at 2.7 cm, while Western classical and rock came in at 2.18 cm and 1.35 cm.
- **THE ROSES** that were exposed to the Vedic chants were also the most floriferous, with an average of 0.68 blooms per plant (not all plants in the groups produced flowers). The plants exposed to Indian classical music averaged 0.6 flowers per plant. The ones exposed to Western classical produced 0.53 per plant, the ones with no music produced 0.48, and the ones exposed to rock produced an average of 0.38 flowers.
- **AS MEASURED** on their second day after fully opening, the average blossom size was 5.4 cm for those exposed to Vedic chants, 5.38 cm for those exposed to Indian classical music, 4.88 cm for those exposed to silence, 4.69 cm for those exposed to Western classical music, and 3.7 cm for those exposed to rock music.

Additionally, the researchers in this study noted the plants exposed to the chants grew towards the music, while the ones exposed to rock tended to grow away from the music source. The ones exposed to rock music also developed thorns first and had the highest average amount of thorns compared to the other groups.

A separate two-year Egyptian study, published in 2017 in the *Life Science Journal*, looked at growth rates, oil production, and pigment variations on salvia plants that were exposed to Western classical, jazz, and silence. The researchers also found that the type of music a plant is exposed to makes a big difference in the data. They looked at total plant height, number of branches per plant, fresh and dry herb weights, percentage of oil yields per plant, and the amounts of total chlorophyll and carotenoids in each plant. With very little exception, the plants exposed to the classical music outgrew and outyielded those exposed to jazz or those that grew in silence. Here are their observations:

- **THE PLANTS** exposed to classical music had the most amount of vegetative growth in both years of the study. Year one averages were 38 cm for those exposed to classical, 36 cm for those in silence, and 34 cm for those exposed to jazz. Year two followed suit, with the ones listening to classical music reaching an average of 38.9 cm, while the ones exposed to silence and jazz music reached only 37 cm and 35.3 cm, respectively.
- **THE PLANTS** exposed to classical music also had the highest average number of branches per plant over both years of the study. They averaged 33 branches per plant in year one and 34 in year two. Plants exposed to silence averaged 30.6 and 31 branches per plant over years one and two, respectively. Plants exposed to jazz music averaged 27 branches in year one and 28 branches during year two.
- **OIL YIELD** from the plants exposed to classical music was higher than that of both the ones exposed to silence and the ones exposed to jazz. Yields in the first year of the study were 2.04 millilitres (ml) for the plants with classical music, 1.09 ml for plants with silence, and 1.07 ml for the ones with jazz. In year two, the yields were 1.1 ml, 1.07 ml, and 1.04 ml, respectively.
- **IN REGARD** to pigment, year one data slightly skewed towards the plants in silence over the plants with classical music, but that trend reversed in year two. Total chlorophyll in year one for plants raised in silence was 2.08 milligrams (mg), 2.02 mg for classical, and 1.95 mg for those exposed to jazz music. In year two, it was recorded as 2.17 mg for classical music, 2.07 mg for no music, and 1.95 mg again for plants exposed to jazz.

> **"THE ONES THAT WERE EXPOSED** to rock music also developed thorns first and had the highest average amount of thorns compared to the other groups."

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> **THE SEEDS EXPOSED** to music germinated almost 20 per cent faster than the control group that was not exposed to music."

There were other benefits for the plants exposed to classical music in this study. They had higher yield weights in both fresh and dry herbs, as well as higher carotenoid levels. This held true for both years of the study.

Another 2017 study, published in the *Romanian Journal of the Young Scientist*, looked at growth rates of wheat when exposed to either classical, no music, or rock (in this case, Led Zeppelin). The wheat in this study grew at an average weekly rate of 3.33 cm when exposed to classical music and 2.33 cm when exposed to no music. When the plants were "getting the Led out," they only grew an average of 1.33 cm per week (apologies to Robert Plant).

One more example is from a Chinese study published in 2017 in *Transactions of the Chinese Society of Agricultural Engineering*. Researchers looked at the yield of soybean sprouts when exposed to five different types of music: piano solos, Chinese classical, rock, pop, and a single frequency for the control. The highest yields were obtained from the soybeans exposed to the piano music at 1.36 kilograms (kg) compared to 1.08 kg of yield from the control group.

Seed Germination

A 2004 study published in the *Journal of Alternative and Complementary Medicine* looked at the impacts that various noises, including music, have on the germination of okra and zucchini seeds. After five iterations of this experiment, music played in the proximity of the seeds had a statistically significant effect on their germination rate. This was regardless of the seed type, the temperature, and the personnel making observations and taking measurements. Overall, the results of this study found that the seeds exposed to music germinated almost 20 per cent faster than the control group that was not exposed to music. As an aside, they also found plants that were exposed to "healing energies" also expressed higher and faster germination rates than the control seed populations.

Even if heavier or harder forms of music are your own personal preference, it looks like the preponderance of evidence suggests plants seem to have a lighter taste and would prefer Bach to the Beatles. With potential benefits of up to 20 per cent more growth and yield, it may be time to garner an appreciation for the music that your great-great-great-great-great-great grandparents used to dance to.

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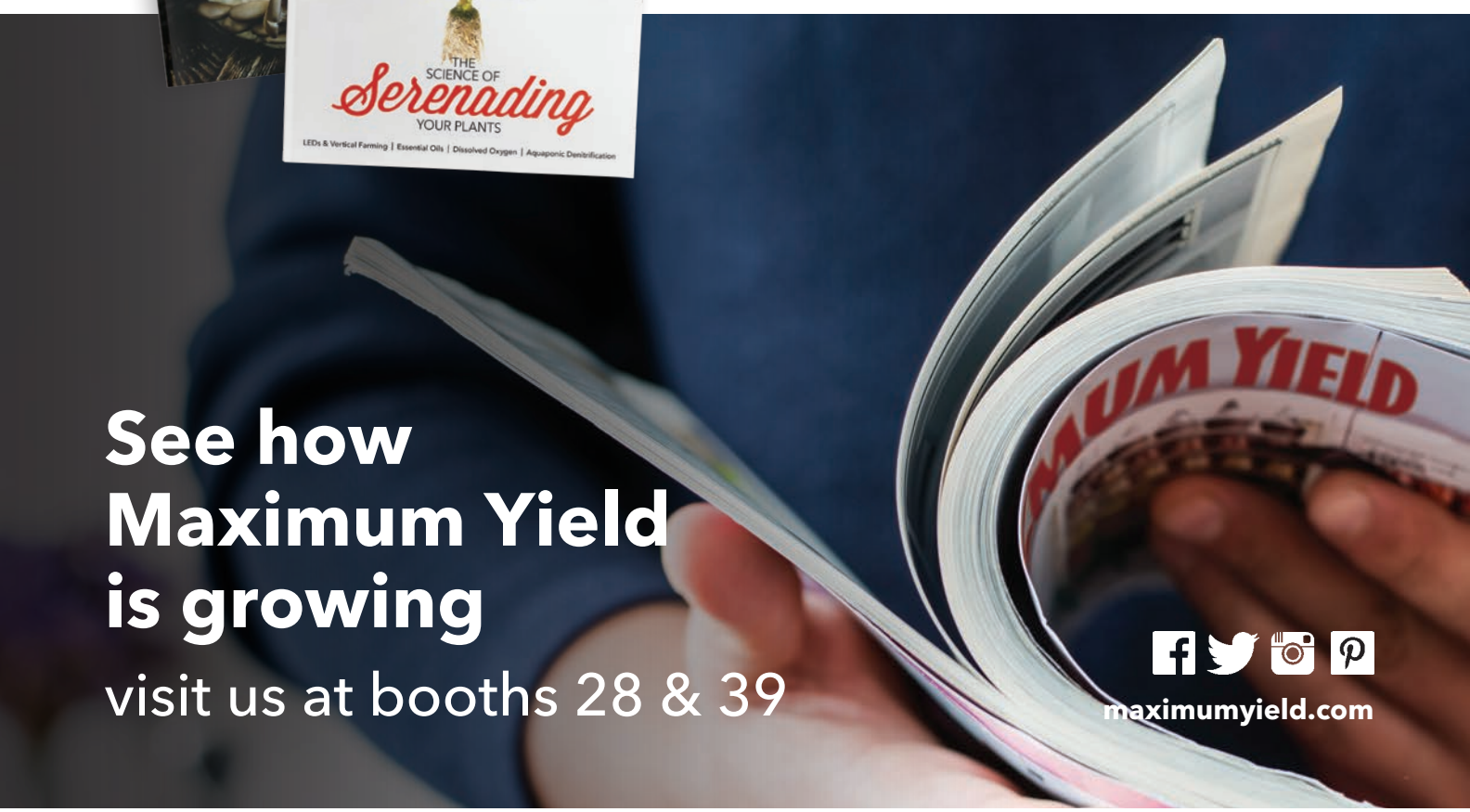

BRIGHT LIGHTS BIG CITY

LED LIGHTING AND VERTICAL FARMING

Vertical farming is all about efficiency, so it's not a big surprise that LEDs are leading the horticultural lighting pack in this new ag industry. Kent Gruetzmacher takes a closer look at the technology and why urban indoor farmers are shelling out the big bucks for it.

by Kent Gruetzmacher

Urban agriculture is gaining acceptance as a viable source for fresh produce in the city. A primary cause for this has to do with the spatial constraints of agriculture. Traditional agriculture utilises vast amounts of farmland that is generally only usable for part of the year. Conversely, urban farmers utilise areas previously deemed unusable for food production. Vertical farming, one of the most promising sectors of urban agriculture, is perhaps the most efficient form of crop production in history when it comes to the efficient use of space. Unlike other forms of urban agriculture, such as community and greenhouse gardens, vertical farming utilises indoor gardening equipment to produce crops without the use of sunlight. As such, vertical farmers can grow crops year-round inside abandoned buildings and shipping containers.

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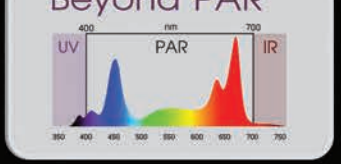

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"LED LIGHTING IS INTIMATELY ENTWINED WITH THE PROGRESSION OF VERTICAL FARMING ON AN INDUSTRIAL SCALES AS ITS CUTTING-EDGE TECHNOLOGY MAKES MASS PRODUCTION POSSIBLE WITHIN THE CONFINES OF INDOOR CULTIVATION."

While vertical farming is an attractive concept due to its versatility concerning seasonality, geography, and spatiality, it has its own constraints. For vertical farming operations to succeed, they must create artificial environments in which plants thrive. The stasis of these artificial environments is dependent on technology that maintains light, humidity, temperature, and air flow. This equipment should also offer farmers affordability and practicality while maintaining these environments.

When it comes to lighting technology, light emitting diode (LED) lighting is leading the vertical farming movement. Here are some reasons why.

TARGETED WAVELENGTHS

One of the most defining characteristics of LED grow lights is the pink light they emit. This uniquely coloured light is tied to the overall operational efficiency of the technology.

The white light of sunlight is what we get when all the wavelengths in the visible light colour spectrum (red, orange, yellow, green, blue, indigo, and violet—or, ROY G BIV) are mixed together. However, researchers have learned plants respond best to red and blue light wavelengths. Traditional indoor grow lighting—high pressure sodium (HPS) and metal halide (MH) lamps—seek to mimic sunlight at certain times of the year and utilise a large portion of the ROY G BIV spectrum in this process. Conversely, LED grow lights cut out the unnecessary wavelengths by only utilising blue and red spectrums. The mix of these two colours results in the pink colour seen in LED growrooms. Also, a majority of the operational, financial, and environmental perks of LED lighting are directly attributable to this breakthrough in light wavelength usage.

SPATIAL CONSTRAINTS AND HEAT

Vertical farming takes the efficient use of space for crop production within cityscapes to its extreme. A distinguishing trait of vertical farming is the layering of garden plots on high-tech shelving units with grow lights dispersed between each level. Some farms feature as many as a dozen layers of crops. Light emitting diode lighting technology can at least be partially credited with the rising popularity of vertical farming as it's the only horticultural lighting technology that can grow crops on a commercial scale within these stacked layers.

While fluorescent lights could function within vertical farms, they don't emit strong enough light to fuel the production of most crops. Traditional HPS and MH lighting don't work for vertical farming either. While these technologies work great for growing crops, they are notorious for emitting excessive heat. The heat issue renders both HPS and MH lights practically useless within the tight confines of vertical farms. In contrast, LED lights can be tightly packed in because they don't emit the excessive heat seen with HPS and MH lights.

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ENERGY EFFICIENCY

All indoor gardening operations are costly to operate, and that cost is exponentially heightened when a large-scale vertical farm operates year-round. The primary financial drawback with vertical farming is that of excessive energy usage (which is also vertical farming's greatest environmental drawback). As vertical farming operations are 100 per cent dependent on indoor gardening equipment, each facet of these complex gardens requires some form of electricity.

The use of LED lights is essential in making vertical farms viable, both financially and environmentally, in the long term. Studies show that LED lighting arrangements are 40-70 per cent more energy efficient than those with HPS and MH lights. On that note, forward-thinking vertical farming companies are also implementing solar power systems to lessen their strain on the power grid.

The urban agriculture movement is rapidly gaining momentum, yet its overall staying power is largely dependent upon the technology that powers its vertical farming operations. Government entities have taken notice of this trend, and resources may soon be dedicated to studying LED technology. All things considered, LED lighting is intimately entwined with the progression of vertical farming on an industrial scale as its cutting-edge technology makes mass production possible within the confines of indoor cultivation.

"THE USE OF LED LIGHTS IS ESSENTIAL IN MAKING VERTICAL **FARMS VIABLE, BOTH FINANCIALLY** AND ENVIRONMENTALLY."


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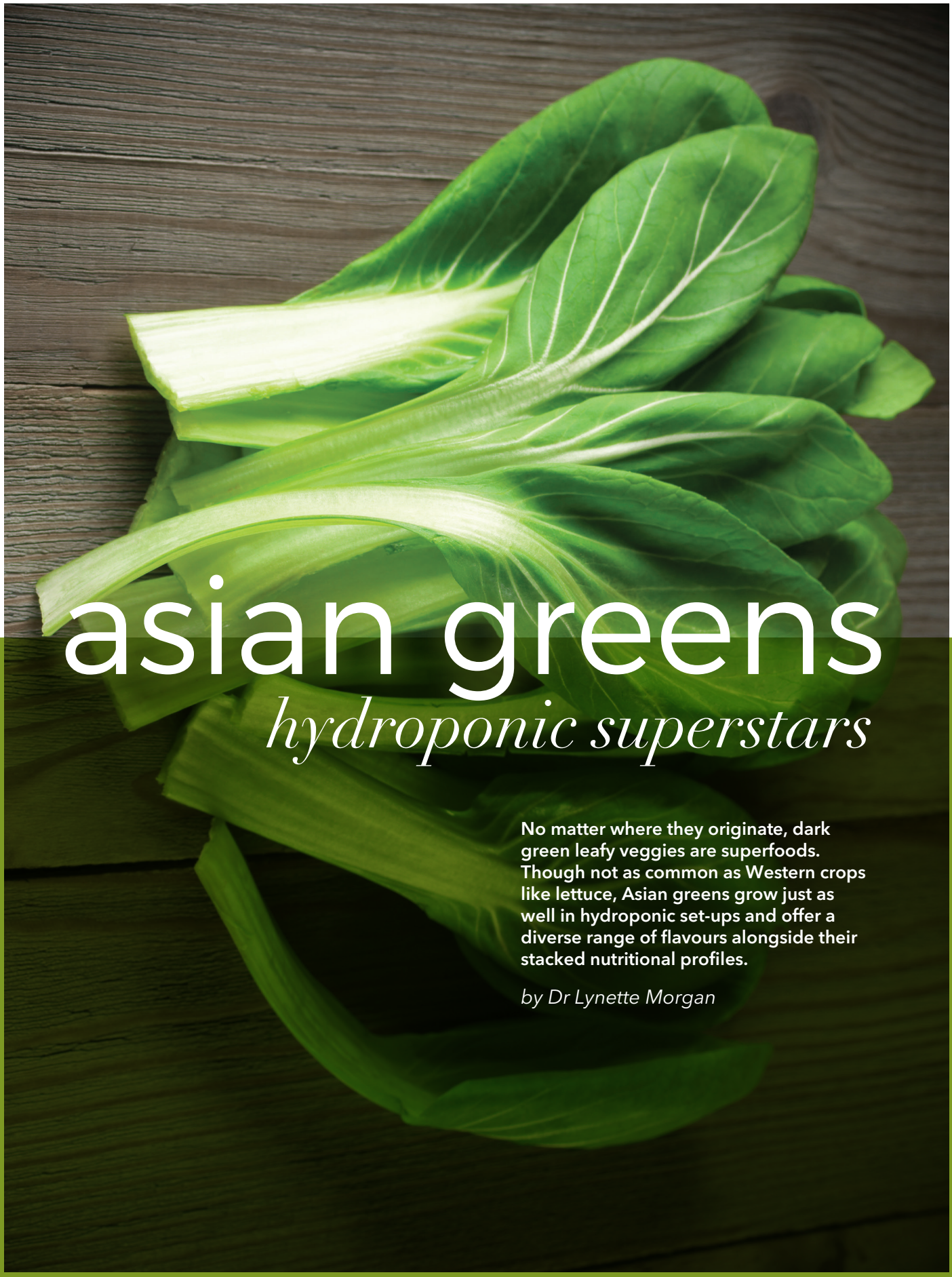

asian greens

hydroponic superstars

No matter where they originate, dark green leafy veggies are superfoods. Though not as common as Western crops like lettuce, Asian greens grow just as well in hydroponic set-ups and offer a diverse range of flavours alongside their stacked nutritional profiles.

by Dr Lynette Morgan

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Dark green leafy vegetables pack a powerful punch, and many of the lesser-known Asian types are no exception. Apart from a high concentration of vitamins, minerals, antioxidants, and beneficial bioactive compounds, leafy Asian greens also have a diversity of flavours, ranging from the mild to hot and spicy with a few other surprising tastes and textures in between. While not as common as lettuce and arugula, gourmet and baby Asian greens are increasingly being grown hydroponically as the recognition and popularity of these versatile products grows. It also helps they're well-suited to hydro growing; most are small, compact plants that mature quickly and can also be grown as microgreens or baby leaf versions. Growers with limited space also have the advantage of selecting some of the newer mini or highly compact hybrid varieties.

Growing Asian greens hydroponically is relatively simple. In fact, it's similar to growing some more familiar crops. Many varieties happily intercrop with lettuce, herbs, and other vegetative crops as they can use the same nutrient formulation and environmental conditions. Most Asian greens like a moderate level of light and a fairly wide temperature range of 12-26˚C, though bolting is common under excessively warm conditions. They are well-suited to hydroponic systems like nutrient film technique (NFT), aeroponics, media beds, and solution cultures such as raft, pond, float, and deep flow technique (DFT).

"Leafy asian greens **also have a diversity of flavours, ranging** *from the mild to hot and spicy with a few other surprising tastes and textures in between."*

Kangkong is a subtropical plant well-suited to hydroponics.

Kangkong (*Ipomoea aquatica*) is known by a few other names, including water spinach, water convolvulus, and ong choy. It has a mild flavour more like lettuce than traditional spinach and can be eaten raw or cooked. There are a couple of different types to choose from, including the bamboo-leaved and broad-leaved varieties. Being a subtropical plant, kangkong prefers warmer conditions above 25˚C. Given these warm temperatures, kangkong grows extremely fast, particularly in hydroponics. It produces succulent, almost swollen stems and large leaves about three weeks after planting out in an aquatic hydroponic system. It also produces well in NFT, DFT, and raft or float systems.

Shungiku provide a unique flavour to Asian dishes.

Shungiku (*Chrysanthemum coronarium*) also known as chrysanthemum greens, edible chrysanthemum, and chop suey greens. It has a distinctive mild flavour that becomes stronger and more aromatic as the plant matures. It can be used as a cooked vegetable, in salads, as a pickle component, and in sushi. There are several types of shungiku, all of which produce well with hydroponics. No matter the variety, plants should ideally be spaced 15-20 centimetres (cm) apart and grown in temperatures of 18-24˚C with an electrical conductivity (EC) of 1.8-2 to prevent plants becoming elongated and leggy. It should also be harvested while still young and tender (when they reach a height of 13-20 cm). While this crop can be raised from seed, shungiku can also be grown on a "cut and regrow" system like most Asian greens. Growers can take cuttings of the shoots every seven days under good growing conditions.

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Red mizuna plants have a rapid growth rate and mild flavour.

Komatsuna has a good degree to cold temperature.

Mizuna (*Brassica japonica*) and mibuna are Japanese greens that are widely grown worldwide. They have an incredibly fast growth rate under warm conditions; they outpace lettuce production by several weeks. Mizuna is very mild and has been grown for centuries in Japan as a staple pickling vegetable, though it is also cooked and used in many other dishes. Many hydroponic producers grow mizuna for use in fresh salad mixes. Mizuna plants produce a dense clump of attractive, finely dissected lime green leaves that can be produced under a cut and regrow system. There are also red/purple varieties that develop more intense red pigmentation when grown under high light levels and cooler conditions. Hybrid varieties of mizuna, which are higher yielding and grow more rapidly than open-pollinated types, are highly suited to hydroponic production. When grown to maturity, mizuna measures 20 cm tall by 30 cm wide. So, plants need wide spaces and frequent cutting to contain their size and growth. Temperatures for mizuna production range from 0-28˚C. This cold hardiness makes mizuna a widely grown winter crop in Japan and one that is well-suited to unheated growing areas. Maximum growth rates, however, occur at 8-18˚C. Under warm growing conditions, mizuna can be ready to harvest in three weeks. Plants can be left to reach a weight of up to 795 grams after four to five weeks of growth.

Mibuna (*Brassica rapa*) is closely related to mizuna, though it has a rounder leaf shape and slightly stronger mustard-like flavour. Hydroponically, mibuna is grown in much the same way as mizuna for salad green production and whole plant sales. However, mibuna requires a wider spacing of 50 cm between plants, is less tolerant of low temperatures, and is more prone to bolting under warmer conditions. EC levels for both mizuna and mibuna are 1.0-1.4 on a well-balanced vegetative nutrient formulation.

Komatsuna (*Brassica rapa var. perviridus*), also known as mustard spinach, is a lesser-known Japanese green related to mizuna and mibuna. Komatsuna produces extremely well under hydroponic cultivation and is available as both red and green hybrid varieties. Komatsuna has a somewhat distinctive flavour somewhere between that of a mustard and a cabbage but not at all like spinach. Plants are upright with round leaves, have a good degree of cold tolerance, and are quick and easy to grow.

"Many varieties happily intercrop with lettuce, herbs, and other vegetative crops as they can use

the same nutrient formulation

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"There are many more exciting and lesser-known
Asian greens to be explored
and experimented with in the hydroponic system and the kitchen."

Mini varieties of pak choi are ideal for small hydroponic systems.

Pak choi (*Brassica rapa spp. Chinensis*), also known as bok choy, is one of the most widely recognised Asian greens. With a mild mustard flavour and thick, succulent stems, it's commonly used in stir fries and soups. Pak choi has both green- and white-stemmed varieties, a wide range of sizes, and those suited to baby leaf production. Newer red varieties of pak choi have an intense purple colour that adds contrast to many dishes and an attractive appearance to any mixed hydroponic system. Hydroponic growers should select compact F1 hybrid types of pak choi to avoid issues with plants becoming overly tall, as well as those with resistance to bolting. While pak choi is considered a cooler season plant, these will perform well in most growroom situations if grown rapidly and harvested young.

Hydroponic raft system used to grow mustard.

There are many types of **mustard greens**, including red varieties and those with large savoyed leaves. Mustard is grown for its characteristic hot, spicy flavour. This heat varies considerably between cultivars and with plant maturity and growing conditions. Many mustard types are traditionally used as pickling vegetables, but those grown as baby leaf and rapid-growing microgreens are used in fresh salads. Hydro-grown mustard requires a relatively low EC to prevent excessive peppery flavours from developing and to help prevent bolting. An EC of 1.0-1.2 is suitable, but this can be reduced if required. Many mustard cultivars are also prone to bolting under warmer growing conditions, so consider these cool-season crops. Selecting slow-bolt varieties and harvesting leaves while the plants are still young also helps largely avoid this problem.

Gai lan is hand-harvested once its yellow or white flowers form.

Gai lan (*Brassica oleracea var. alboglabra*), also known as Chinese kale or Chinese broccoli, is characterised by long, thick, tender green stems. It has a mild flavour lightly reminiscent of broccoli with slightly bitter overtones. This traditional green is commonly used raw in salads, steamed, or lightly cooked in a similar way to broccoli. Gai lan shoots are individually hand-harvested by snapping it at the base once its yellow or white flowers have formed but before it's too mature. While gai lan is becoming a popular hydroponic crop, it requires more space than most other compact Asian greens. The plants spread up to 40 cm in diameter and can reach 45 cm tall by the time the flower buds develop and the stems are suitably thick for harvesting. Gai lan grows rapidly under warm growing conditions (18-28°C), though there are varieties that can be selected for cool cropping conditions.

Misome plants grown within a nutrient film technique system.

Tatsoi thrives in solution culture hydroponic systems.

Misome (*Brassica campestris narinosa*) is a highly attractive and productive Asian green with a degree of heat resistance, making it a good choice for intercropping with tomatoes, peppers, and other warm-season crops. Growth rates are rapid, with production times as low as 20 days in NFT systems. Under hydroponic production, misome is typically grown to a young stage as a microgreen or for baby leaf salad mixes. The mature plant, with its thick, crisp light green stems, makes a great addition to cooked dishes such as soups and stir fries.

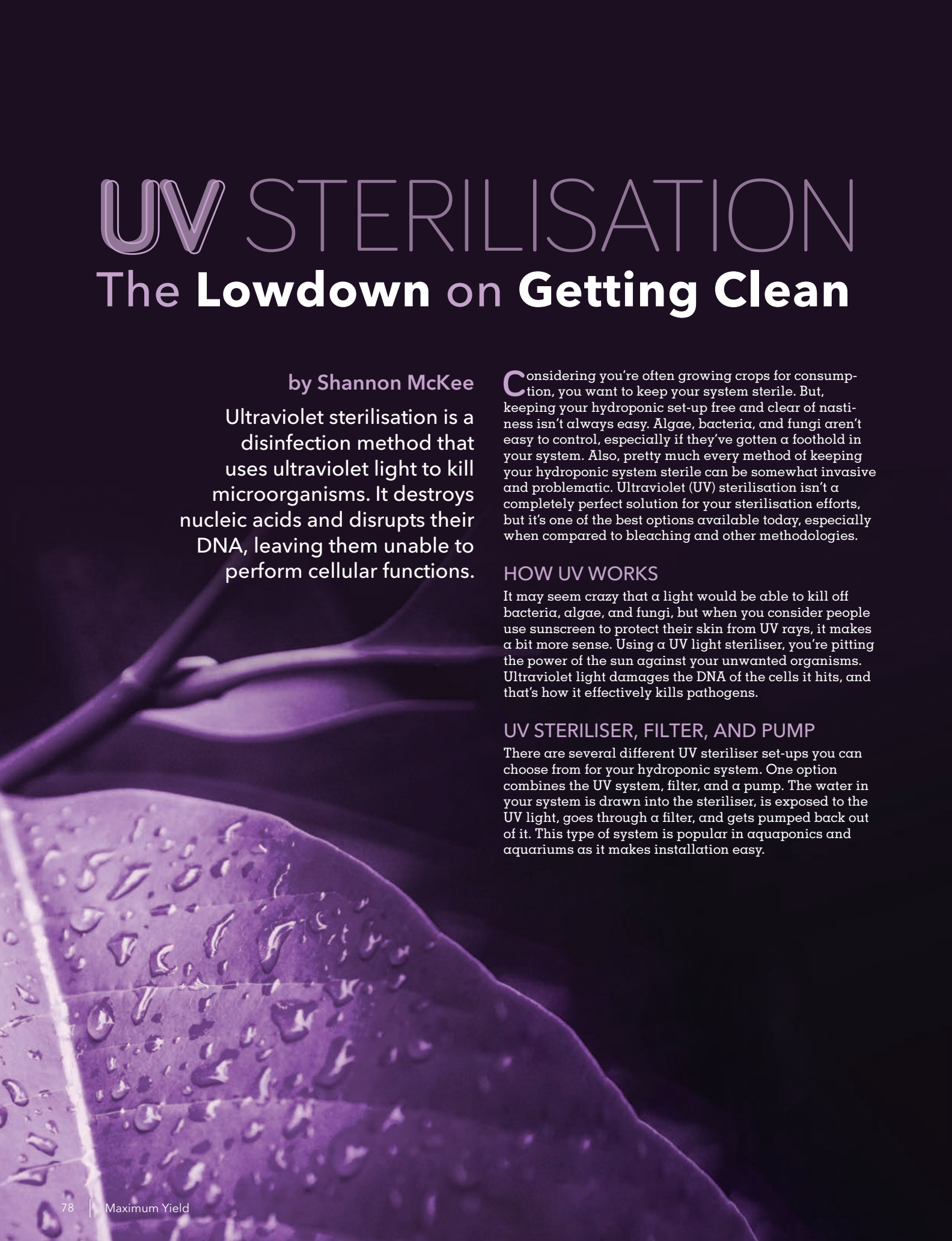
Tatsoi (*Brassica rapa var. rosularis*), also called spoon mustard or spinach mustard, is an underutilised Asian green. Individual baby leaves are commonly seen in salad mixes, but the mature plant is short and compact and forms a dense rosette of attractive rounded leaves. Tatsoi is mild in flavour, and it grows rapidly under hydroponic production. If growing mature plants, it's ideal to space them 13-15 cm apart; however, a higher density can be used for baby leaf production.

There are many more exciting and lesser-known Asian greens to be explored and experimented with in the hydroponic system and the kitchen. What's more, new varieties are continually developed to offer improved colours, faster production times, higher yields, and adaptation to a wider range of growing conditions. Given the diversity, range of flavour, and attractive appearance of Asian greens, it is worth reserving a little space for them in any indoor garden.

UV STERILISATION
The **Lowdown** on **Getting Clean**

by Shannon McKee

Ultraviolet sterilisation is a disinfection method that uses ultraviolet light to kill microorganisms. It destroys nucleic acids and disrupts their DNA, leaving them unable to perform cellular functions.



Considering you're often growing crops for consumption, you want to keep your system sterile. But, keeping your hydroponic set-up free and clear of nastiness isn't always easy. Algae, bacteria, and fungi aren't easy to control, especially if they've gotten a foothold in your system. Also, pretty much every method of keeping your hydroponic system sterile can be somewhat invasive and problematic. Ultraviolet (UV) sterilisation isn't a completely perfect solution for your sterilisation efforts, but it's one of the best options available today, especially when compared to bleaching and other methodologies.

HOW UV WORKS

It may seem crazy that a light would be able to kill off bacteria, algae, and fungi, but when you consider people use sunscreen to protect their skin from UV rays, it makes a bit more sense. Using a UV light steriliser, you're pitting the power of the sun against your unwanted organisms. Ultraviolet light damages the DNA of the cells it hits, and that's how it effectively kills pathogens.

UV STERILISER, FILTER, AND PUMP

There are several different UV steriliser set-ups you can choose from for your hydroponic system. One option combines the UV system, filter, and a pump. The water in your system is drawn into the steriliser, is exposed to the UV light, goes through a filter, and gets pumped back out of it. This type of system is popular in aquaponics and aquariums as it makes installation easy.

"THE WATER in your system is drawn into the steriliser, is exposed to the UV light, goes through a filter, and gets pumped back out of it."

SEPARATE UV STERILISER

There are also set-ups where the UV steriliser is separate from the filter and pump. Though the units are separate, they work in conjunction with each other. Like the previous system, the water goes in and out, but it's just set up a bit differently. This type of steriliser may not sit inside of your system, but piping will create intake and outlet points for the water to move.

IN-LINE UV STERILISATION

Another option is in-line UV sterilisation, which allows you to sterilise your lines and the water flowing through them. This means water is treated as it flows into the treatment area. This configuration is helpful when using beneficial microbes in your set-up and reducing the problems with nutrient reduction as it may not be as impactful. However, if you already have a problem with algae, bacteria, or fungi in your system, this set-up does not help eliminate it. Any algae attached to the walls and other surfaces needs to be removed another way.

BIGGEST DRAWBACK WITH UV STERILISATION

One of the biggest drawbacks in using UV sterilisation is that it can deplete some of the things your plants need to grow healthy and strong. Iron, boron, and manganese deficiencies can occur when using UV sterilisation. Also, UV sterilisation reduces the populations of any beneficial microbes in your hydroponic set-up much in the same way it does the fungal, bacterial, and algal populations. It's beneficial to test your hydroponic system for these deficiencies to help minimise them.

Ultraviolet sterilisation can be an excellent option for keeping your system free of bacteria, fungi, and algae that can turn your set-up into a nasty problem. While it does have drawbacks, proper management and testing can help to reduce these issues. Once set up and dialled in, UV sterilisation can give you clean and clear water that makes you and your plants happy.

ENGINEERS **WITHOUT BORDERS** *in Sri Lanka*

Anxious to help communities devastated by the 2004 Indian Ocean tsunami, students from Germany's Karlsruhe Institute of Technology formed Engineers Without Borders to put their building skills to good use. Fourteen years later, the organisation now has 340 members and 12 projects across the globe, the most recent being a complex aquaculture system in the Sri Lankan village of Padiyatalawa.

"Vast areas of Sri Lanka were devastated, and students from Karlsruhe Institute of Technology in Germany felt they needed to act to support people who lost their homes, loved ones, livelihoods, hopes, and dreams."

In the small village of Padiyatalawa and the surrounding areas, most families survive by working in agriculture. The region is located in the Eastern Province of Sri Lanka. Here, the climate is very dry, with sufficient precipitation only falling between November and January. During the dry season, most springs and wells evaporate. An adequate supply of water to irrigate fields and operate agriculture during the dry season is not guaranteed and large parts of the population live on only one harvest a year.Other than agriculture, the region offers few job opportunities, so many residents get by working as day labourers.

SRI LANKA DEVASTATED BY TSUNAMI

These already difficult working and living conditions were exacerbated in 2004 after a massive tsunami struck countries along the Indian Ocean. Vast areas of Sri Lanka were devastated, and students from Karlsruhe Institute of Technology (KIT) in Germany felt they needed to act to support people who lost their homes, loved ones, livelihoods, hopes, and dreams.

"Unfortunately, almost all of the (relief) funds went into the coast tourist regions and barely any reached the poor countryside areas like Padiyatalawa," says Jonas Bruns, a member of KIT's Engineers Without Borders. "When we realised that, we started long-term projects like the construction of bridges and a bakery for war widows."

ENGINEERS WITHOUT BORDERS MAKES IMPACT

Since 2004, Engineers Without Borders has grown significantly, with current membership at 340 students. Together, they are working on 12 projects around the globe, including the newest: an aquaponic complex in Padiyatalawa.




"Through the construction of the aquaponic facility and the development of a sustainable operational concept, we want to give the local inhabitants further perspectives," says Bruns. "Targeted training is intended to familiarise the residents with the technology of aquaponics, thereby ensuring long-term and independent use of the facility. We strive for a sustainable use of resources and access to a balanced diet for everyone."

To achieve that, the KIT team developed the project with local people, ensuring younger generations will learn and be able to pass that knowledge on to future generations.

Aquaponics combines growing vegetables and fish farming in a highly efficient manner. The objective is to achieve water-efficient and ecological agriculture in a single closed system. The fish are used to create fertiliser until they are big enough to be sold or used as food. They are then replaced by smaller fish.

"This system ensures, above all, that the plants always have enough water and nitrate at their disposal to effectively produce their fruits," says Bruns. "At the same time, this has the further advantage that the plants in this way clean the polluted water. The clean water is directed back into the fish tanks and is again available to the fish as purified water and the cycle closes."

"Other than agriculture, the region offers few job opportunities, so many residents get by working as day labourers."

The idea for the project was initiated by Janaka Kosgolla. Born and raised in Sri Lanka, Kosgolla earned a doctorate in mechanical engineering from the University of South Florida. Seeing how aquaponic systems benefitted communities in other countries, Kosgolla researched an aquaponic facility in Padiyatalawa and searched for partners. Engineers at KIT responded and, together, the team has spent the last year building the unit and educating the local farmers on how to sustain it.

"We are planning a system consisting of several separate modules to better control the system. The spatial separation of the modules ensures that if one module is compromised, the others are not affected," says Bruns. "The modular design of the system also makes it possible to build the project in several construction phases."

FOUR BASINS USED IN COMPLEX SYSTEM

The aquaculture of each module consists of four spatially separate basins in which fish of different growth stages are located. This way, the amount of excretions produced by the fish is constant. The four basins have a total volume of 30 cubic metres and are connected to the overall water circulation of the module. The nutrient-enriched water is passed through the filter systems in the cultivation area. To ensure the plants' sensitive environmental balance, sensors and personnel may need to constantly review important water values, such as ammonium or nitrate levels.

In the grow beds, different types of vegetables such as peppers, tomatoes, eggplants, cucumbers, and much more are grown, providing healthy meals for the hard-working people of Padiyatalawa.

distribution **LIST**

retail stores are listed alphabetically by city 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

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 6511

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

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

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

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

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

Lux 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
nutriflo.com.au

Outside in Hydroponics & Organics
2/595 Main Rd.
Glendale NSW 2285
(02) 4956 5676

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

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

Quik Grow
510a Great Western Hwy.
Pendle Hill NSW 2145
(02) 9636 7023

Quick Grow
823 King Georges Rd.
S. Hurstville NSW 2221
(02) 9546 8642

Quik Grow Pty Ltd.
490 Parramatta Rd.
Petersham NSW 2049
(02) 9568 2900

Richmond Hydroponics
Unit 3/84 Bells Line of Rd.
North Richmond NSW 2754
(02) 4571 1620
richmondhydroponics.com.au

Simple Grow
Hassall St. & Windem
Wetherill Pk NSW 2164
(02) 9604 0469

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

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

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

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

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

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

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

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

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

VN Hydro
8 Robert St.
Belmore NSW 2192

Home Grown Aquaponics
13/8a-8b Hartley Dr.
Thornton NSW 2322
(02) 4028 6388

Warrawong Hydroponics Centre
Shop 2B - 72 Cowper St.
Warrawong NSW 2502
(02) 4274 8001
warrawonghydro@hotmail.com

Westside Lighting & Electrical (Ezi Range)
PO Box 274
Mascot NSW 1400
1 800 661 475

Wollongong Hydroponic Centre
318 Crown St.
Wollongong NSW 2500
(02) 4225 8773

NORTHERN TERRITORY

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

Katherine Hydroponics Centre
17 Rundle St.
Katherine NT 0850
(08) 8972 1730

Top End Hydroponics
1785 Leonino Rd.
Darwin River NT 0841
(08) 8988 6076

QUEENSLAND

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

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

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

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

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

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

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

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

E.T. Grow Home
Unit 1/4 Windmill St.
Southport QLD 4215
(07) 5591 6501

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

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

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

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

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

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
26 Spencer Rd.
Nerang QLD 4211
(07) 5527 4155

HydroMart Hydroponics
4/12 Natasha St.
Capalaba QLD 4157
(07) 3823 3169 & (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 Goodwood 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
Shop 3/146-148
Findon Rd. Findon SA 5023
(08) 8244 0222

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

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

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

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

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

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

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

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

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

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

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

Koko's Hydro Warehouse
Unit 2/2 McGowan St.
Pooraka SA 5095
(08) 8260 5463

Larg's Bay Garden Supply
239 Victoria Rd.
Largs Bay SA 5016
(08) 8242 3788

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

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

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

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

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

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

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

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

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

Seaton Hydroponics
129 Tapleys Hill Rd.
Seaton SA 5023
(08) 8268 2636

Soladome Aquaculture & Hydro
44 Chapel St.
Norwood SA 5067
(08) 8362 8042

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

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

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

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

Urban Grow Solutions
1/111 Main Sth Rd.
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.
Burton SA 5110
(08) 8280 3314
warehouseofgarden.com.au

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

TASMANIA

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

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

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

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

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

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

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

Hydroponic World
322 Bass Hwy.
Sulphur Creek TAS 7316
(03) 6435 4411

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

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

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

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

The Hydroponics Company
289 Hobart Rd.
Kings Meadow 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

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

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

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

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

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

Crown Garden Supplies
8 Glencapel Crt.
Hillside VIC 3037
(04) 5996 6344

Discount Hydroponics
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

Hyalite 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 Melbourne 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 Rd.
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
18/10 Norton Dr.
Melton VIC 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.
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One Stop Sprinklers
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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

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
Factory 9/1-3 Burke Rd.
Braybrook VIC 3019

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

Smart Hydro Garden
3/4 Lacy 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
(08) 264-3600

The Hydroponic Connection
5/393 Dorset Rd.
Boronia VIC 3155
(03) 9761 0662

Urban Hy
Unit 1-59 Gilbert Park Dr.
Knoxfield VIC 3180
(03) 9764 9400

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
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Thomastown VIC 3074
(03) 9465 1455

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

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Morley WA 6062
(08) 9375 9355

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

Aquaponics 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
(08) 9452 0546

Greenfingers World of Hydroponics Midvale
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Midvale WA 6056
(08) 9274 8388

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

Growsmart Hydroponics
47768 South Coast Hwy.
Albany WA 6330
(08) 9841 3220

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
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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 St.
Neerabup WA 6031
(08) 9404 7155

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Bayswater WA 6053
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Perth Hydroponic Centre
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Belmont WA 6104
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Reptile and Grow Store
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Rockingham WA 6168
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reptileandgrow.com

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Joondalup WA 6027
(08) 9301 4462

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Mandurah WA 6210
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Cannington WA 6107
(08) 9356 7044

The Great Indoors
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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
(08) 9495 1495

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

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Armandale WA 6112
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tolesasgrowsmart.com.au

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Bibra Lake WA 6163
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Water Garden Warehouse
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Osborne Park WA 6017
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New Lynn, Auckland
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Easy Grow Manukau
15/69 Wiri Station Rd.
Manukau, Auckland
(09) 263 7560

Guru Gardener
14 Molesworth St.
New Plymouth
(06) 758 6661

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

House of Hydro
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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

Green Day Hydroponics
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Mt Maunganui
(07) 575 4090

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

Hyalite Glenfield
7/67 View Rd.
Glenfield
(09) 443 0106

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

Hyalite Hastings
513 Heretaunga St.
West Hastings
(06) 876 7885

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

Hyalite Linwood
9 Buckleys Rd.
Linwood
(03) 381 0937

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

Hyalite Nelson
3 Pascoe St.
Nelson
(03) 546 4769

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427 Cameron Rd.
Tauranga
(07) 579 9840

Hyalite Upper Hutt
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Upper Hutt
(04) 526 3913

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

Hyalite Whangarei
189 (Lower) Dent St.
Whangarei
(09) 438 0223

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FACTS ON

APHIDS

Aphids, they're such cute little things... **not.**

ANYONE WHO has done any gardening is likely to have met the aphid, a small, sap-sucking insect often found tended to by ants in outdoor gardens.

APHIDS ARE soft-bodied, pear-shaped creatures that come in many colours. Most are wingless, but winged individuals do appear.

IN ADDITION to the direct damage they cause, aphids, depending on the species, are vectors for as many as 100 different plant viruses.

IN SMALL numbers, aphids do minimal damage, but infestations are highly destructive, causing discolouration, spotting, or puckering of leaves.

APHIDS ARE hemipterans, or "true bugs" (not flies or beetles, for example). All species of Hemiptera—there are tens of thousands—areS united in classification by their similar sucking mouthparts.

MOST APHIDS simply suck up cell contents with their piercing mouthparts, but a few inject toxic substances with their saliva.

APHIDS CAN reproduce rapidly by giving birth via unfertilised eggs. An individual can produce several hundred offspring in a month.

AS IS generally the case, inspecting plants at an early growth stage to remove insects goes a long way toward preventing large populations later.

THEN THERE are the ants. Ants and other insects are fond of the energy-rich "honeydew" waste exuded by aphids. So much so that they protect and transport aphids to new locations for them to feed.

LADYBIRDS are the classic natural enemy of aphids but are often only temporarily effective. Aphids are susceptible to attack by fungi, which can be encouraged by moisture. Insecticidal soaps and oils are effective chemical controls.

by Philip McIntosh


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