AUSTRALIA September/October 2016

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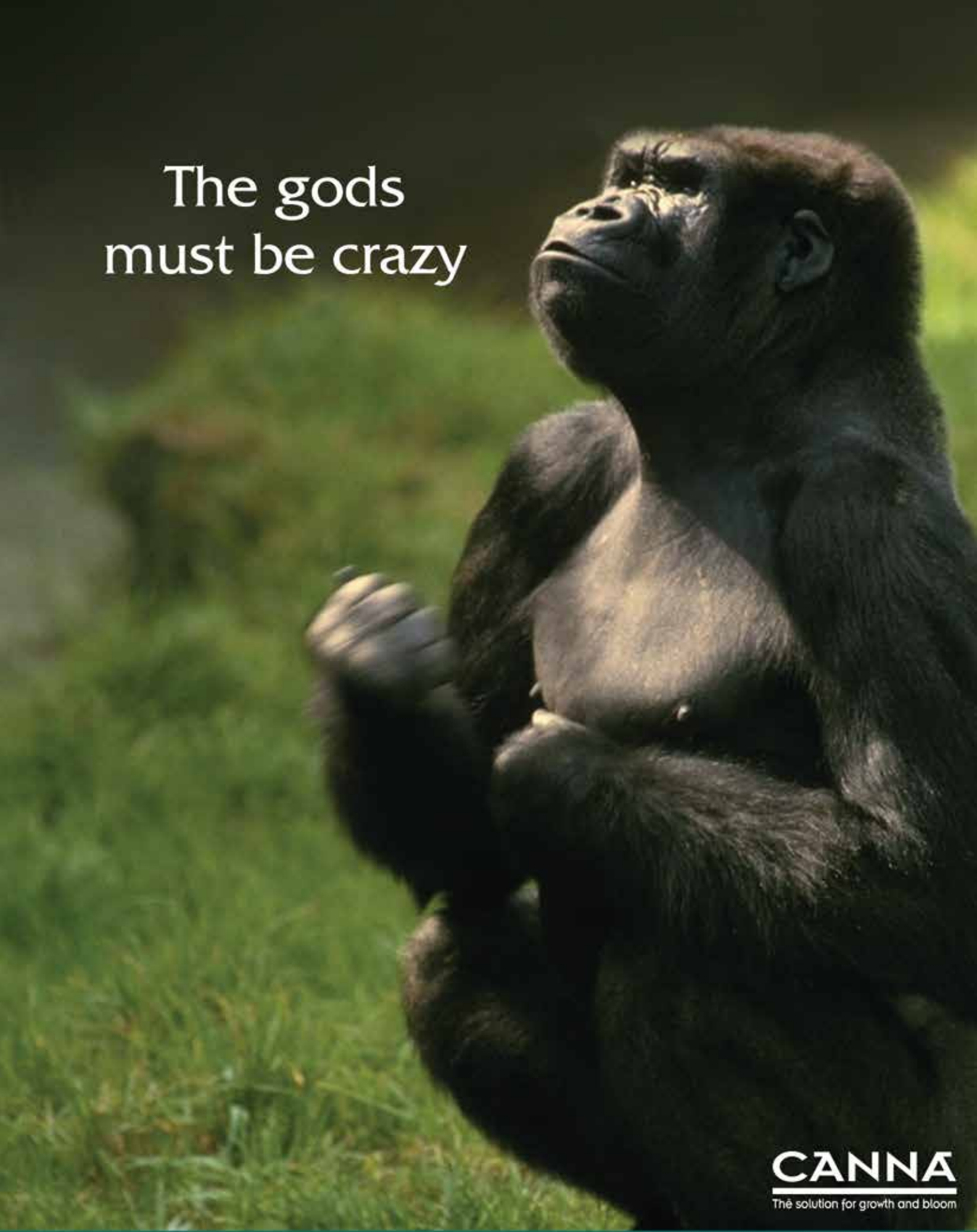
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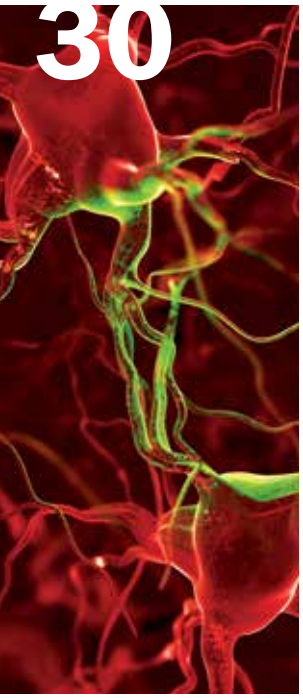

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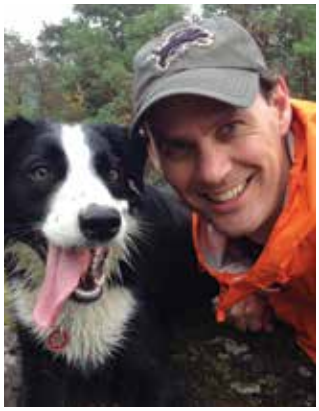
FROM THE EDITOR | TOBY GORMAN



Maintaining a successful growroom lies in the subtleties. It's in the record keeping, day-to-day habits, keeping your tools and growroom clean and comfortable and sticking to a tried-and-true watering and feeding schedule.

With a strong foundation of work ethic and knowledge, your plants will grow stronger and healthier, and your harvest will be more rewarding.

That alone is incentive to work harder and learn more about growing. Whether you are a hobby grower or it's your vocation, there is always more to learn about growing indoors.

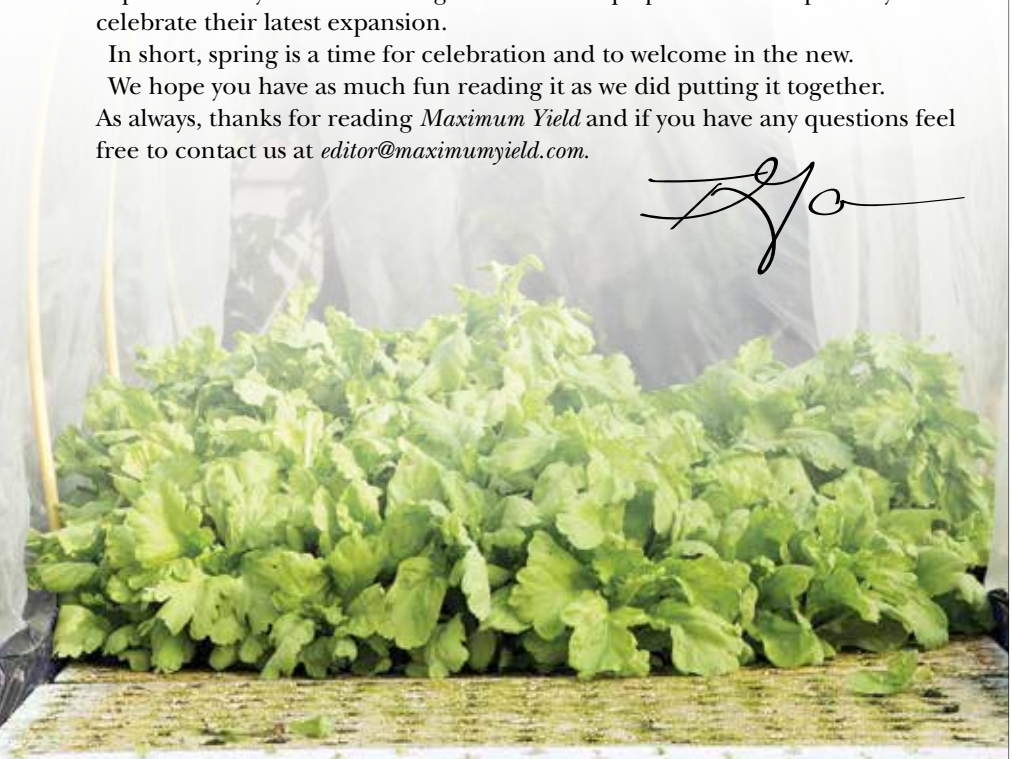
For many, spring is a time to take stock of the upcoming growing season. It's an opportunity to look back into that notebook to see what worked and what didn't with the last crop, and what tweaks can be made to improve the next crop. It is also a time to look forward to your growroom and embrace the ever-improving technical advances manufacturers strive every day to create. It might be worth a trip down to your local retailer and see what is new in the industry.

In this issue, we explore a few of those details that could be tweaked to improve your indoor garden. We start with Dr. Lynette Morgan's piece on the Daily Light Integral, an illuminating and informative article on maximising the use of your lighting systems. You might want to pull your notepads out for this one. We follow that up with transplanting and hardening off plants; the science behind companion planting; why your garden needs phosphorous; and 10 reasons to look into aquaponics.

Speaking of aquaponics, for this issue we worked closely with the nice people at Perth's Aquaponics WA and Hydroponic Xpress for our Talking Shop segment. Overcoming many challenges, the van Aurich family has worked hard to become Western Australia's largest hydroponic and aquaponics retailer. It's a great success story, and if you happen to be in the Perth area on September 10 you are encouraged to attend Aquaponics WA's Open Day to celebrate their latest expansion.

In short, spring is a time for celebration and to welcome in the new.

We hope you have as much fun reading it as we did putting it together. 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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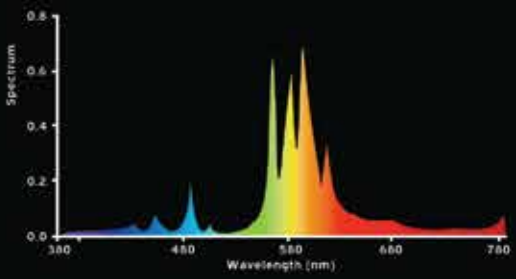

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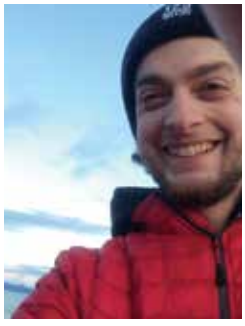
LETTERS TO THE EDITOR

Rob Quinlan

Grower Shares Story of How He Advanced

I started indoor gardening just over a year ago as a fun hobby. At first, I used a sunny windowsill as a main light source. When my plants started stretching for more light, I knew I would have to purchase something but I had no idea what to buy. I started doing research online and decided on an expensive set-up I thought would be the best I could get for my situation. I found a local indoor garden store called Rootdown Hydroponics in Medford, Massachusetts, and told them what I was interested in purchasing. The friendly clerk took the time to draw up my garden room and explained that the light I was ready to buy ran very hot and was quite a bit more than I needed since my ceiling was only six-feet high. He instead gave me some information on many other lighting options and a free issue of *Maximum Yield*. When I got home, I read your magazine front to back and was amazed at all of the great new products that are advertised within that I could also research. It is one of the few publications where the ads are as informative as the articles. I went back to the store more educated and chose one of the lights the clerk had suggested which I also saw in *Maximum Yield*.
Rob Quinlan



Aaron Ford

Magazine Benefits Alaskan Grower

Maximum Yield brings together new technology and ideas from all different fields of cultivation. Everything from indoor hydroponics to greenhouse methods is represented in the same magazine. This is especially important to me since gardeners in Alaska need to make the best of the amazing outdoor summer climate before moving indoors during the long winter. Soil biology and careful soilless media management are equally important in order to keep the veggies growing year-around in Alaska. We are somewhat isolated from the mainland up here, so I am grateful for the window into gardening culture around the world. *Maximum Yield* is the only magazine I read!
Aaron Ford

Editor's Note: Rob and Aaron have each won cash prizes to spend at their favourite indoor gardening shops for telling us why they love *Maximum Yield*. Could you use a few extra bucks to spend at the hydro shop? Enter Maximum Yield's I'm a Fan contest at *maximumyield.com/contests* for your chance to win.

Mad About Saffron

I was interested in your article about hydroponically growing saffron. What I'm wondering is if you have any ideas on speeding up the overwinter process. I imagine if the saffron is responding to the climate or something like that it would be easy to coax into quicker re-emergence (and flowering) but if it's some form of timer I suppose there's not much to be done. I'm growing saffron indoors and they just now started to go into their hibernation. Any ideas you have would be really appreciated.

Editor's Note: From what our expert Chris Bond could find, there is no getting around at least a 12-week overwintering period where the corm needs to be dark and cool. However, it does not need to be longer than this though, he says.

CONTRIBUTORS

Eric Hopper'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.

Jeremiah Robinson lives two lives. By day, he's an energy efficiency engineer for a large firm. By night, he designs cold-climate aquaponic systems for Frosty Fish. Creator of the Zero-to-Hero DIY aquaponics construction manual and writer of the *frostyfish.com* blog, he dreams of raising fish on the moon.

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

Guy Sela is an agronomist and a chemical engineer at his innovative software company, Smart Fertilizer (*smart-fertilizer.com*), which provides fertiliser management solutions. Applying his background in water treatment, he has led a variety of projects on reverse osmosis, water disinfection, water purification, and providing high-quality water for irrigation.

Frank Rauscher is a certified horticulturist and consultant for the gardening industry. He's a contributing author to several publications and was writer and editor of the *Green Pages*. Frank finds analysing plant stress and finding solutions exciting. He loves bringing new ideas to the field of horticulture and indoor gardening.

Harley Smith is the director of research for NPK Industries. A veteran in the hydroponics industry, Harley has more than 18 years of consulting and educating experience. He is regarded as an expert on plant nutrition and organic biostimulants, performing research and new product development in the US and Europe.

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Q **I'd like to start growing my own vegetables, but I live in an apartment. What types of veggies are going to be the easiest to start growing on the balcony? —Melissa**

A If you live in an apartment as I do and want to start growing your own vegetables, start with tomatoes. They're a staple of most diets, they're versatile and most importantly they're easy to grow while still providing something of a challenge. I'm not as lucky as my neighbour, whose balcony looks like a miniature farm, but I'm happy with what I've achieved over the years. You'll find your homegrown tomatoes are sweet and flavourful, even if they're half the size of the ones you buy in the store. Here are a few of my favourite tips for growing tomatoes. Hopefully this will help you avoid my failures and start you off at a better place than I was my first year.

If you're just starting out, transplants are the way to go. I tried growing from seed in my apartment and found it didn't work. Most likely because I'm lucky to hit 19°C in my apartment and tomato seeds best germinate at 23°C. Plant the transplants deeper then they come in the pots, even as far as the middle of the plant or beyond. Those little white hairs on the stems will actually turn into roots when underground. The deeper the plant, the more roots will grow and the stronger your plant will be.

Next, water the soil, not the leaves. Overhead watering is more likely to spread disease and should be avoided. Fortunately, in many apartment complexes, balconies are built directly above one another. This means as long as you don't live on the top floor, your tomatoes have a surprising amount of protection from wind and rain. This gives you a greater amount of control over the water your plant receives for optimal growth. Once your tomato plant is roughly three feet tall and has yet to fruit, get ride of about a third of the leaves from the bottom because they are more likely to develop fungus and other pathogens that can spread to the rest of the plant.

You will need to be aware of suckers. Suckers are those little stalks that grow in between the intersection of two branches of your plant. For all intensive purposes, they are weeds. They will consume energy and resources that could be going to the actual fruiting portions of your plants. Some argue against their pruning, and it appears to be dependent on what kind of plant you have, with it being beneficial for more upright varieties like Roma, called indeterminate type, and bad for bushy or determinate types like early girl or cherry.

Tomatoes need their space and it's better to start off with a big enough container rather than move up as the plant grows. It is recommended tomatoes have roughly two feet of space on their own, or from each other, but I've had success with smaller planters. Some argue it's best to grow tomatoes in an upside down planter where the roots are on top and the plant grows out of the bottom. I haven't noticed much of a difference, but this might be because the planter I used was actually a recycled yogurt container.

My last piece of advice? Do not apply fresh compost on the soil of your plant! You may think putting food scraps directly on the soil of your plant along with a couple of worms is a good idea, but it isn't. Tomatoes like a lot of fertiliser, but it's best to use compost that has significantly rotted or that has been purchased from the store. I've made this silly mistake throughout the years—please learn from me.

Elizabeth Marsh grows of all kinds of vegetables, not just tomatoes. She has written for *Monday Magazine* and the *Escapist Online* and is a founding member of *The Marble*, a blog dedicated to the theater scene in British Columbia, Canada.

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Flower Bud Uniformity Beholden to Time, Space

A study of sepals in Arabidopsis plants published in the journal *Developmental Cell* has revealed the mystery of how flower uniformity occurs. The researchers found that although plant cells grow at different rates and in separate directions, such variability averages out over time. In this way, the growth rates of plant cells average out to be more equal as organs develop. Similarly, over time, cells randomly growing in different directions fall into an average uniform direction that follows the architecture of the organ. This principle, called spatiotemporal averaging, is dependent on cells maturing and stopping growth at the right time to create flowers on a plant that are the same size and shape. The researchers identified a gene, FtsH4, that affects the accumulation of reactive oxygen species (ROS) which, in effect, stiffens cell walls. When cell walls become stiff enough, contents within the cell run out of room to grow, and the cell matures.

– *sciencedaily.com*

MAX FACTS
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Are Your Lettuce Seedlings Going Blind?

In lettuce seedlings, blindness occurs when the main apical shoot or growing tip of the lettuce is lost during the seedling's early growth. It is sometimes called multiple heading or apical meristem decline. A similar disorder also occurs in brassicas such as cabbage and in tomato seedlings. Lettuces seldom recover from blindness; instead, they develop into a distorted, unmarketable plant with no proper heart. In severe cases, blindness can affect more than 30 per cent of seedlings. Ideally, affected lettuce should be removed from trays and replaced with healthy plants by the seedling producer. Symptoms of blind lettuce vary. While the lack of a strong central growing point is the key identifier, the apical shoot may be stunted, deformed or there can be multiple, competing central shoots. In a truly blind plant the older leaves are often thickened, stunted and distorted. However, chemical burn from sprays applied at too high a rate can cause symptoms similar to blindness. Grower beware!

– *soilwealth.com.au*

New Resource Aims to Improve Mental Health of Farmers

Researchers in Australia have developed a world first: a website that aims to improve the mental health of farmers specifically. The website aims to help farmers, who traditionally have among the highest rates of suicide across the globe, with effective coping techniques and prevention methods. The new program is being developed by researchers at the University of South Australia in collaboration with the University of Adelaide, National Centre for Farmer Health and the Freemasons Foundation Centre for Men's Health. "The main thing that it is going to focus on is helping farmers deal with things that are beyond their control," says Kate Fennell, lead researcher. The farmer's mental health site will be used primarily as an information hub but will also include a discussion board where users can interact with other people and share their frustrations in a professionally moderated environment. Dr. Fennell believes the site will be launching by mid-2017.

– *theleadsouthaustralia.com.au*

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Dealing with Citrus Gall Wasp

September is the ideal time of year to check your citrus trees for gall wasp and remove affected sections by pruning well below the gall. Don't compost this stuff! Instead, cut through the gall to expose the larvae to air before throwing it in the rubbish. You could soak the galls in water for a week or two, or burn them. Also consider hanging sticky yellow traps on the tree to trap the emerging adults. Do not use a high-nitrogen fertiliser, as this promotes soft growth that provides ideal conditions for the wasps. Finally, use a biological form of control. Megastigmus brevivalvus and Megastigmus trisulcus are natural enemies of citrus gall wasps. They lay their eggs inside the eggs of citrus gall wasps, destroying them. They are sold to home gardeners in some states, but are only available for a two-week window around October and November.

– sgaonline.org.au

Students Get Involved in Hydroponics Project

Seven Hills High School students have teamed up with Sydney-based charity Sprouting Good to develop hydroponic and aquaponic farms at the school. Sprouting Good founder and chief executive Scott Gregory's vision is to bring commercial rooftop greenhouse farming to Australia and along the way he wants to enthuse schoolchildren, the consumers of tomorrow. The school now has a blooming and productive garden complete with raised beds, chickens, rabbits and the Sprouting Good aquaponics set-up that involves a 500-litre water tank containing 30 silver perch fish, which produce nutrients for the attached vertical garden. "In Australia, particularly around the cities, we have seen residential expansion, which in some cases is taking up farming land. The aquaponics and hydroponics systems are a way of getting around that," says Gregory. Students in Year 9 tend the garden while younger pupils visit the garden where teachers help them learn about fresh food.

– dailytelegraph.com.au

More Kids Benefiting from Fruit in New Zealand Schools

Health Minister Jonathan Coleman says this year's expansion of the Fruit in Schools programme is seeing a record volume of fresh produce delivered to 547 schools across the country, benefitting more than 100,000 students. "Healthy eating helps fuel the body and the brain, that's why the Fruit in Schools programme is so beneficial to students," says Coleman. "Fruit in Schools complements the Childhood Obesity Plan. New Zealand is one of the first OECD countries to have a target and a comprehensive plan to tackle childhood obesity." Following the Ministry of Education's decile funding changes, all existing schools have remained in the Fruit in Schools programme. So far this year more than 11 million pieces of produce have been served up to kids in schools across the country. Schools sample up to 24 different types of fruit or vegetable during the year.

– health.govt.nz

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Meat Blamed For Greenhouse Gas Emissions

It may be delicious, but the evidence is accumulating that meat, particularly red meat, is just a disaster for the environment—and not so great for human beings, either. Agriculture today accounts for one-third of global greenhouse gas emissions—posing one of the biggest challenges to countries desperately trying to curb the emissions that promote global warming. And half of those agriculture emissions come from livestock, which produce large amounts of methane, a short-lived but powerful greenhouse gas. The environmental impact is the driving reason why members of a United Nations panel have urged its environmental assembly to consider recommending a tax on meat producers and sellers. Raising the cost of buying meat, the argument goes, would reduce demand, and ultimately, production of it. By no means is meat the only element of agriculture that contributes greenhouse gas emissions. Deforestation of land for agricultural purposes also adds to the amount of carbon dioxide in the air.

– washingtonpost.com

New Zealand Welcomes Frozen Bananas

Local fruit company OOB Organic has claimed a New Zealand first with the launch of the only frozen banana product. In a busier-than-ever society where convenience foods that don't compromise on taste and nutritional value are at the top of the shopping list, OOB Organic Sliced Bananas give shoppers the opportunity to enjoy certified organic bananas in new ways. OOB Organic sales and marketing manager Erik Tams says, "We know bananas are Kiwis' favourite fruit so we wanted to give everyone the opportunity to enjoy bananas in a frozen format all year-round." The snap-frozen technique ensures the high quality of the product remains without the texture or colour of the banana changing. "While smoothies are the most popular use for frozen fruit, Sliced Bananas can be used in anything from baking to cooking or a snack. The ability to portion control how much you need prevents unnecessary wastage," says Tams.

– oob.co.nz

How to Test a Drip Irrigation System

A catch-can test is a simple way to determine if a drip irrigation system is delivering water evenly. While the system is running, use shallow containers to catch water delivered by at least nine drippers for one or two minutes periods. Test drippers should be spaced along lateral lines near the inlet, middle and end of at least three lines. These lines should be spaced throughout the block, preferably at the start, middle and end, and at different slopes. After waiting one or two minutes, measure the water caught for each dripper by sucking it into a syringe and reading the volume in millilitres or cubic centimetres. Multiplying millilitres by 60 for a one-minute sampling time or by 30 for a two-minute sampling time gives the volume being delivered from a dripper in millilitres per hour. Comparing the amount caught throughout the field or growroom will indicate whether your system's delivery is even.

– agric.wa.gov.au

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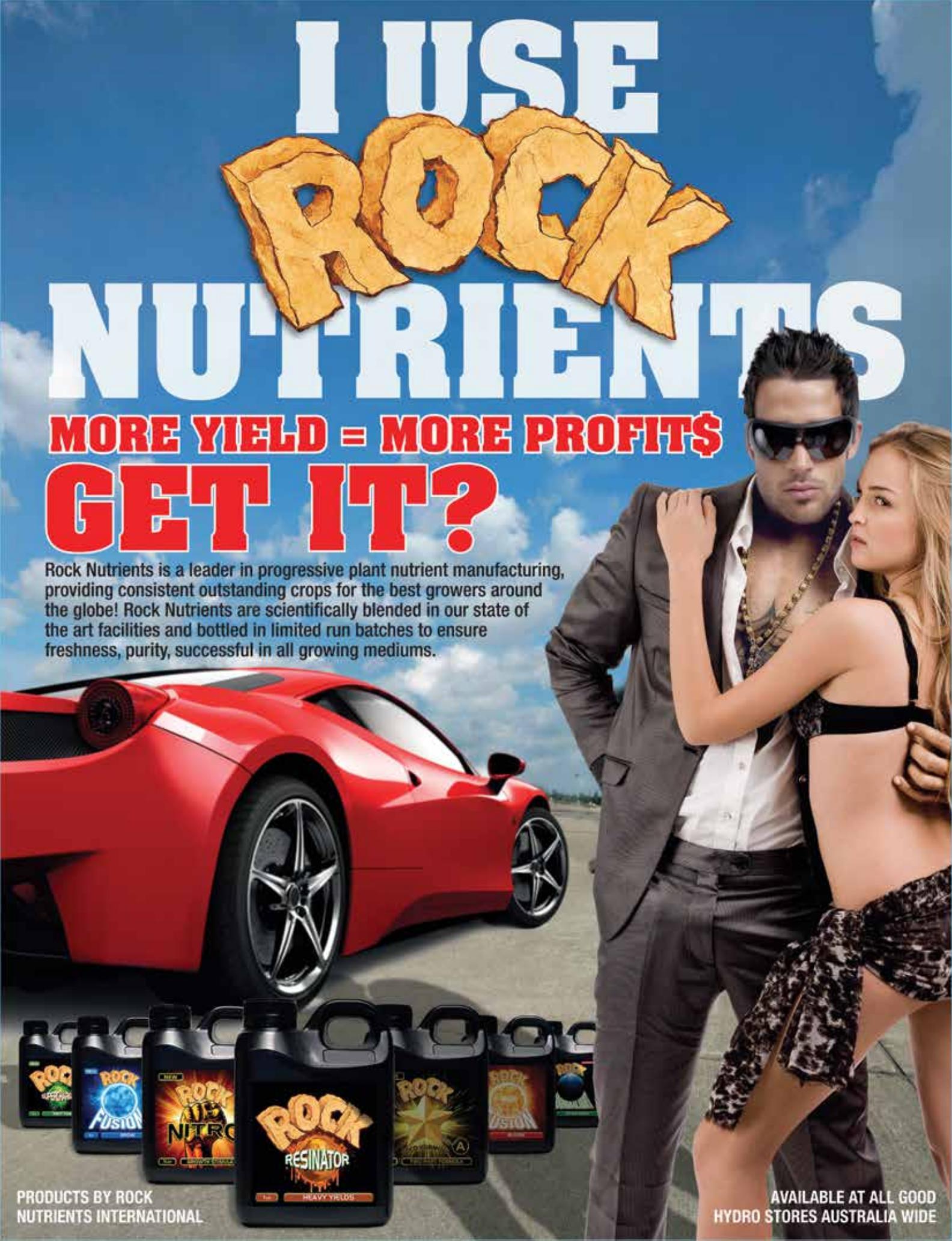
Uber Nutrients Re-Cover is the only product on the market that was specifically designed to reverse and correct the less-than-desirable visual and physical side effects that can occur with the use of commonly used height-controlling plant-growth regulators. The use of PGR height controllers often results in plants with little essential oil production and moderate sized, but very compact and hard flowers that are then susceptible to moulds. Re-Cover fixes these common symptoms of PGR stress by restarting growth and development pathways, thus reviving cell division. This accelerated regeneration gives you yet another big burst in flower size that returns proper density to the flowers and gives you sweet-smelling, fully mature plants. Re-Cover is free from PGRs and harsh chemical agents; it restores your plants through the use of an acetylated form of lecithin and its unique TRx1 Peptide Suite. Re-Cover your lost sales today!

G8-600 Veg/Flower Light

The G8-600 Veg/Flower light by G8LED is a powerful indoor growing machine. This grow light has the growing power of 1,000 W of HID lighting while only using 390 W of power. The G8-600 uses G8LED technology to produce high-quality buds while operating at low temperatures. Eight built-in fans make indoor temperature control easy while helping you save big on your monthly electrical bills.

Gorilla Grow Tent Shorty 2x4

Gorilla Grow Tent's 2x4 Shorty fits perfectly in countless locations that present height limitations. With this tent size, growers are no longer limited by low ceilings. The Shorty has all of the design features of a regular-sized Gorilla Grow Tent, but in a petite size for convenience. It is also height-adjusting, standing proudly at four feet, 11 inches, and may be extended to five feet, eight inches tall with the included nine-inch height-extension kit. This height-adjusting capability makes Gorilla Grow Tents the most versatile tents on the market. The Shorty line also boasts 100 per cent steel frames, the best zippers in the industry, EZ-view windows, convenient tool pouches and sturdy spill trays.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Hydropro Water Pumps, the new powerhouses in the hydroponics industry, are high-quality statuary pumps that are small and compact. Due to a new, unique, robust impellor design, they are popular for their exceptionally long life in hydroponic systems. The three pumps in the Hydropro Water Pumps range all feature exceptional head pressure to increase flow when under load. They contain a built-in flow adjustor, a half-inch threaded inlet for plumbing for dry-mount inline use, an improved, extra-tough clutch system on the impellor, and a three-core safety cable. They are distributed in Australia and New Zealand by Aquatec Equipment. For more information on the complete Hydropro Water Pump range, visit a stockist near you.

Kind LED L300

Kind LED Grow Light's K3 series L300 is comprised of high-powered, three-watt LEDs and feature a proprietary, intensified 12-band spectrum designed for producing large yields. This revolutionary series of LED grow lights produce the biggest and best yields, while consuming less electricity and producing virtually no heat. The K3 L300 LED grow light effectively showers a 2x3-foot grow area with enough light to yield a more-than-successful indoor harvest. With its small-but-effective footprint, the K3 L300 LED grow light is widely considered the best replacement for 300-W HPS and HID grow lights. What this means is that closet growers can get larger outcomes from a small grow space. Kindest Yields. Kindest Spectrums. Kind LED.

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O_2 Grow 1010

O_2 Grow has expanded its offering of oxygenating devices. Ideal for the home grower, the O_2 Grow 1010 will oxygenate up to 10 gallons of water in less than three hours. The O_2 Grow product line from the Oxygen Research Group will raise oxygen saturation levels 50 per cent higher than what air stones can achieve. The O_2 Grow emitter technology works by electrically separating the water molecule into hydrogen and oxygen. The pure oxygen is then re-absorbed back into the water. Supplemental oxygen is important whether you are growing hydroponically or in soil. Oxygen at the roots helps prevent root disease, enhances nutrient uptake and increases flower and fruit yield. O_2 Grow emitters come in a range of sizes able to oxygenate water reservoirs from 10 gallons up to 250 gallons.

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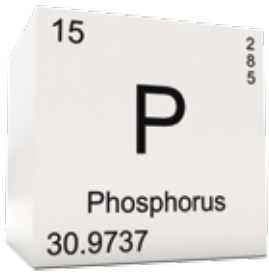

PHOSPHORUS

by Harley Smith

Plants must have a steady supply of phosphorus from seed to harvest. It's called the energy element for a reason! As one of the macronutrients, phosphorus puts the P in N-P-K ratios on fertiliser labels around the world. Read on to discover why your plants love it so much and the ways you can ensure they always have enough.


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"ADDING A LITTLE EXTRA PHOSPHORUS DURING THE FIRST TWO-THREE WEEKS OF VEGETATIVE GROWTH CAN HAVE A DRAMATIC EFFECT ON ROOT STRIKE AND THE ESTABLISHMENT OF PLANTS."

Phosphorus is the energy element, essential to the chemistry of life. It is part of a molecule called ATP (adenosine tri-phosphate) that serves as the energy currency of plants. Energy from photosynthesis and respiration is temporarily stored in the high-energy phosphate bonds. When the phosphate bonds are broken, energy is released to activate a series of chemical reactions in plants. If a plant doesn't receive adequate phosphorus, its energy needs can't be fully met. The plant's new growth will be stunted, both at the roots and at the shoots, and as phosphorus deficiency worsens, the plant will eventually shut down and die. An adequate amount of phosphorus is required throughout the entire life cycle of a plant, and lack of available phosphorus is often the limiting factor for plant growth.

Phosphorus is not very mobile in soil. It is easily adsorbed or locked up with other minerals, making it unavailable to plants. Very little plant-available phosphorus is actually dissolved in the soil solution. In fact, adsorbed phosphates on soil particles are often hundreds to thousands of times greater than phosphates in the soil solution. As a plant takes up the phosphates from the soil solution, the adsorbed phosphates slowly take their place, but they are sometimes not fast enough to meet the energy needs of the plants. Plants must have a steady supply of phosphorus from seed to harvest.

Boost Phosphorus with Mycorrhizal Fungi

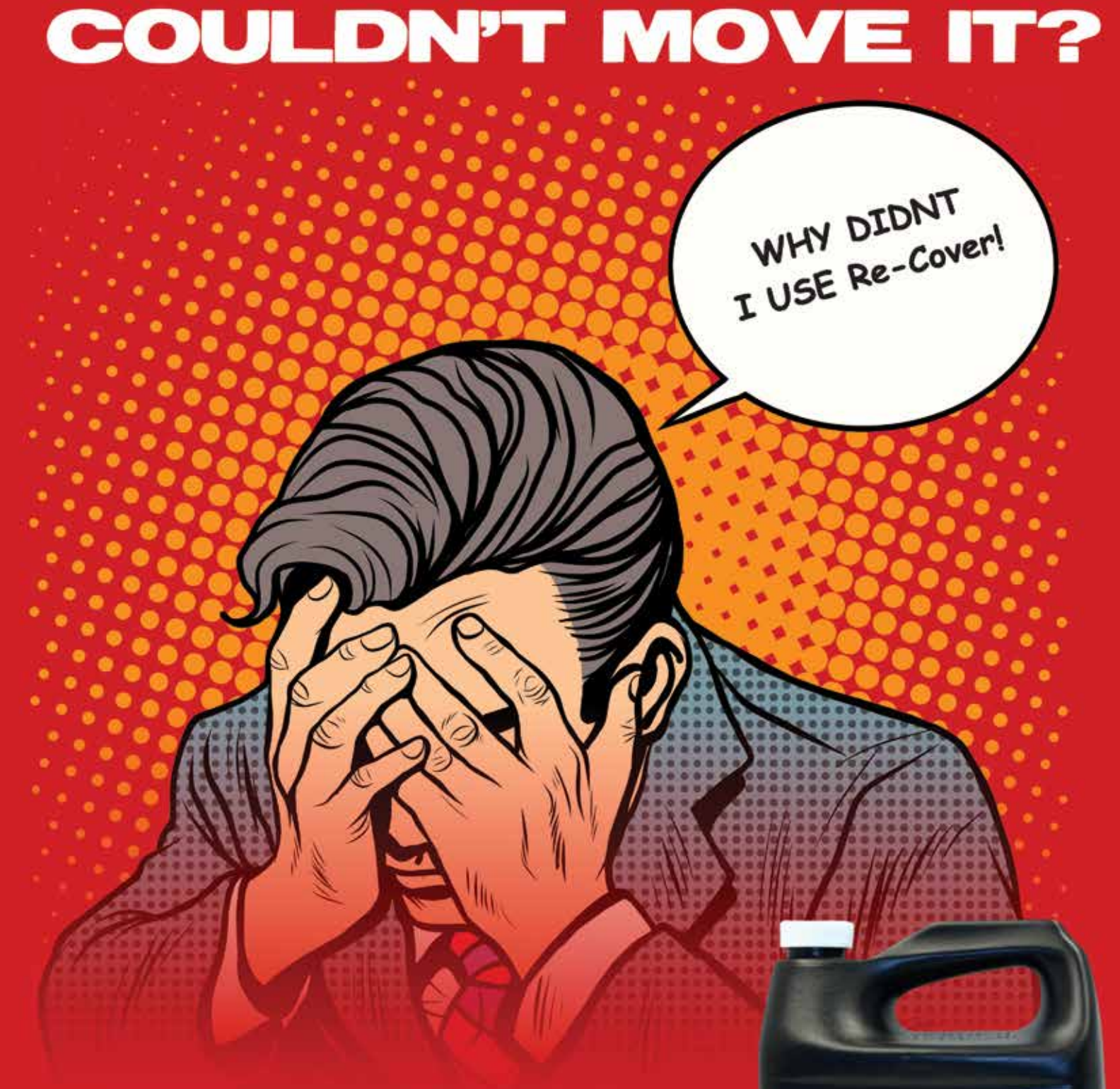
In nature, mycorrhizal fungi help plants take up phosphorus. The fungi penetrate root cells and send out hyphae (thread-like structures), seeking out water and precious phosphorus in the surrounding soil and organic matter. The fungi exude enzymes and organic acids to make the phosphorus soluble, then feed it to the roots of the plant. In exchange, the plant exudes sugars to feed the mycorrhizal fungal. Usually, it's a good trade. In fact, if there is a phosphorus deficiency in the soil, plants will exude signal molecules to attract mycorrhizal fungi. On the other hand, if there is plenty of water-soluble phosphorus, plants will exude enzymes to repel mycorrhizal fungi, treating them as a pathogen.

Organic gardeners using relatively insoluble forms of phosphorus such as bone meal and rock phosphate should consider inoculating roots with mycorrhizal fungi. But for even better results, adding phosphorus-solubilising bacteria along with the mycorrhizae is a powerful combination. The beneficial bacteria hitch a ride on the fungal strands and swim to places in the soil solution the fungi can't reach. The bacteria then exude enzymes to release phosphorus from the surrounding soil and organic matter and make it more available to the mycorrhizae. Phosphorus-solubilising bacteria feed the fungi, and the fungi feed the plants.

Water-soluble Forms

One of the benefits of hydroponics is the availability of water-soluble phosphorus. Even so, the phosphates must be kept separate from calcium ions in concentrated form. That's why hydroponic nutrients often come in two-part and three-part formulas. All of the calcium is in one bottle, and all of the phosphates are in the other bottle. If the two were combined in concentrated form, the calcium would react with the phosphates to form calcium phosphate, which is 95 per cent insoluble. Both the calcium and the phosphates would lock up, precipitate out of solution and become unavailable to the plants. But once diluted in enough water, the calcium and phosphates remain soluble in solution to be easily absorbed.

COULDN'T MOVE IT?



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Mono-ammonium phosphate (MAP), a highly water-soluble form of phosphorus, is often included in starter fertilisers used by commercial growers. The additional phosphorus energises the rooting process, and the ammonium is quickly assimilated through the developing roots to produce growth hormones and enzymes. Adding a little extra phosphorus during the first two to three weeks of vegetative growth can have a dramatic effect on root strike and the establishment of plants. Lab tests have shown up to a 20 per cent increase in root mass with nutrient formulas supplemented with a moderate increase of MAP during the early vegetative growth stage.

Phosphorus During Fruiting and Flowering

Another key stage for phosphorus application is during the fruiting and flowering stage. Most hydroponic bloom formulas provide phosphorus in the form of mono-potassium phosphate, providing adequate phosphorus throughout this phase. But sometimes plants need a boost. For example, during the transition from grow to bloom, a great deal of energy is diverted to flower production, and the plant may not be able to keep up with the extra energy demand. A little supplemental phosphorus during the early flowering stage can give a plant the energy boost it needs, promoting earlier flowering and more flowering sites.

During heavy fruit and flower production, plants continue to require higher levels of phosphorus to help provide energy for the developing fruit, but higher levels of potassium are also important for increased carbohydrate metabolism. That's why there are many P-K boost formulas on the market. Generally speaking, phosphorus and potassium are both important during the fruiting and flowering stage, but increased phosphorus is particularly beneficial during the early flowering stage, while increased potassium is particularly beneficial during heavy fruiting and flowering. If you want to fine-tune the nutritional needs of your plants, it's best to spoon-feed phosphorus and potassium separately whenever possible.

Watch Your Temperatures

Phosphorus uptake is temperature-dependent. If your nutrient solution is too cold, plants won't take up adequate amounts of phosphorus. Plant growth will stall, and the stems and undersides of the leaves may even start to turn purple. When using phosphorus fertilisers, carefully follow dosing directions and try to make sure the nutrient solution stays above 14°C. For best results, maintain the nutrient temperature between 20 and 24°C.

Don't Overdo It

It is possible for plants to develop phosphorus toxicities. If excess phosphorus starts to build up in the reservoir, plants may take up too much all at once. There are no direct symptoms of phosphorus toxicity—it shows up first as a zinc deficiency, then as an iron or magnesium deficiency. One reason phosphorus levels become too high is the addition of phosphoric acid to the solution. Many hydroponic growers use phosphoric acid to lower the pH of their nutrient solution, but since phosphoric acid is actually a phosphorus fertiliser, it can quickly build up to toxic levels if too much is used. Moderation is the key.

Phosphorus additives are beneficial when they are used in the correct amounts at the correct times. Learn to spoon-feed your crops to give them exactly what they need when they need it. A little extra phosphorus can energise the rooting process and stimulate the flowering process, but too much at the wrong time can have adverse effects. Manage your phosphorus fertilisers wisely and your plants will reward you with heavy yields of vibrant flowers and tasty fruits. MY

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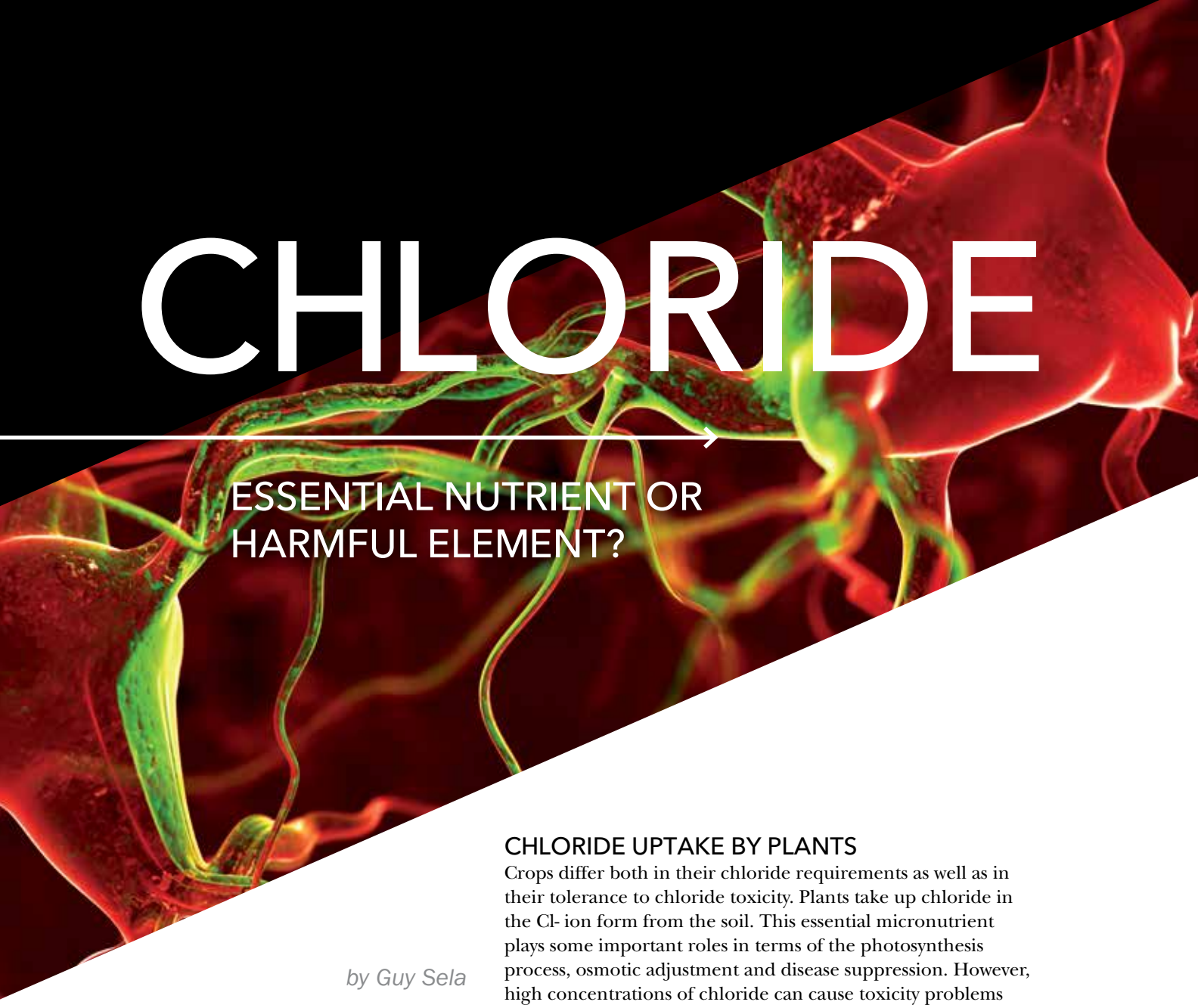


CHLORIDE

ESSENTIAL NUTRIENT OR HARMFUL ELEMENT?

by Guy Sela

CHLORIDE IS AN ESSENTIAL MICRONUTRIENT AND ALL CROPS REQUIRE IT IN SMALL QUANTITIES. HOWEVER, IT IS OFTEN ASSOCIATED WITH SALINITY DAMAGE AND TOXICITY. HERE'S THE SCOOP ON WHAT TO DO ABOUT CHLORIDE IN A SOIL-BASED GARDEN.

CHLORIDE UPTAKE BY PLANTS

Crops differ both in their chloride requirements as well as in their tolerance to chloride toxicity. Plants take up chloride in the Cl- ion form from the soil. This essential micronutrient plays some important roles in terms of the photosynthesis process, osmotic adjustment and disease suppression. However, high concentrations of chloride can cause toxicity problems in crops and reduce yields. The toxicity results from the accumulation of chloride in the leaves.

TOXICITY SYMPTOMS

Common symptoms of chloride toxicity in plants include necrosis of leaf margins and tips, which typically occurs in older leaves first. Excessive leaf burn might eventually result in leaf drop. However, it can be difficult to diagnose chloride toxicity because it is often hard to determine whether the toxicity symptom is directly related to chloride or to other elements that are usually absorbed with it, like sodium. Chloride can also cause leaf damage when it is deposited on leaves during overhead irrigation.

SOURCES OF CHLORIDE

In many cases, a sufficient amount of chloride is supplied to plants from the atmosphere and precipitation, as rainwater

> "CROPS DIFFER BOTH IN THEIR CHLORIDE REQUIREMENTS AS WELL AS IN THEIR TOLERANCE TO CHLORIDE TOXICITY."

usually contains low concentrations of chloride. Chloride might become a limiting factor for plant growth in areas that are far from the sea. Natural sources of chloride in groundwater include the weathering of rocks, atmospheric deposition and precipitation.

In coastal, arid and semi-arid areas, the available groundwater is higher in salinity. Since chloride is an anion (carries a negative charge), it does not adsorb to soil particles and instead moves readily with the water in the soil. Therefore, water quality and irrigation management are the major factors that affect chloride concentrations in soil.

Water of low-to-medium salinity contains 100 to 300 milligrams of chloride per litre. For example, if the source water contains 100 milligrams of chloride per litre, irrigation of 30,000 litres per hectare a day will result in the addition of 1,095 kilograms of chloride per hectare a year to the field.

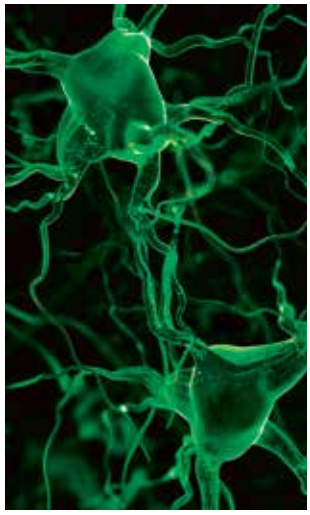
Chloride is also in some fertilisers. For example, the most common fertiliser containing chloride is KCl (muriate of potash), which contains 47 per cent chloride and 53 per cent potassium. Fertilising with 500 kilograms of KCl per hectare will result in the application of 235 kilograms of chloride per hectare. Other chloride-containing fertilisers include $CaCl_2$, NH_4Cl and $MgCl_2$.

CHLORIDE IN SOIL ANALYSIS

Since chloride does not bind to soil particles, its level in soil is tested in an aqueous soil extract, such as with a saturated paste of one part soil to two parts distilled water.

IRRIGATION MANAGEMENT

Irrigating with water that contains chloride requires appropriate practices in order to keep chloride levels in the soil below the threshold levels tolerated by the crop. Excess chloride should be leached below the active root zone. Water containing a chloride concentration of less than 150 milligrams per litre are safe for most crops, provided that proper irrigation management practices are applied.



Although chloride is an essential micronutrient, it is often overlooked as a plant nutrient. A positive response to the application of fertilisers containing chloride have been reported in different crops in many parts of the world. However, at high concentrations, chloride might be toxic to many crops and contribute to overall salinity. Proper irrigation and fertilisation management practices should be taken into consideration in places where irrigation water contains high concentrations of chlorides. MY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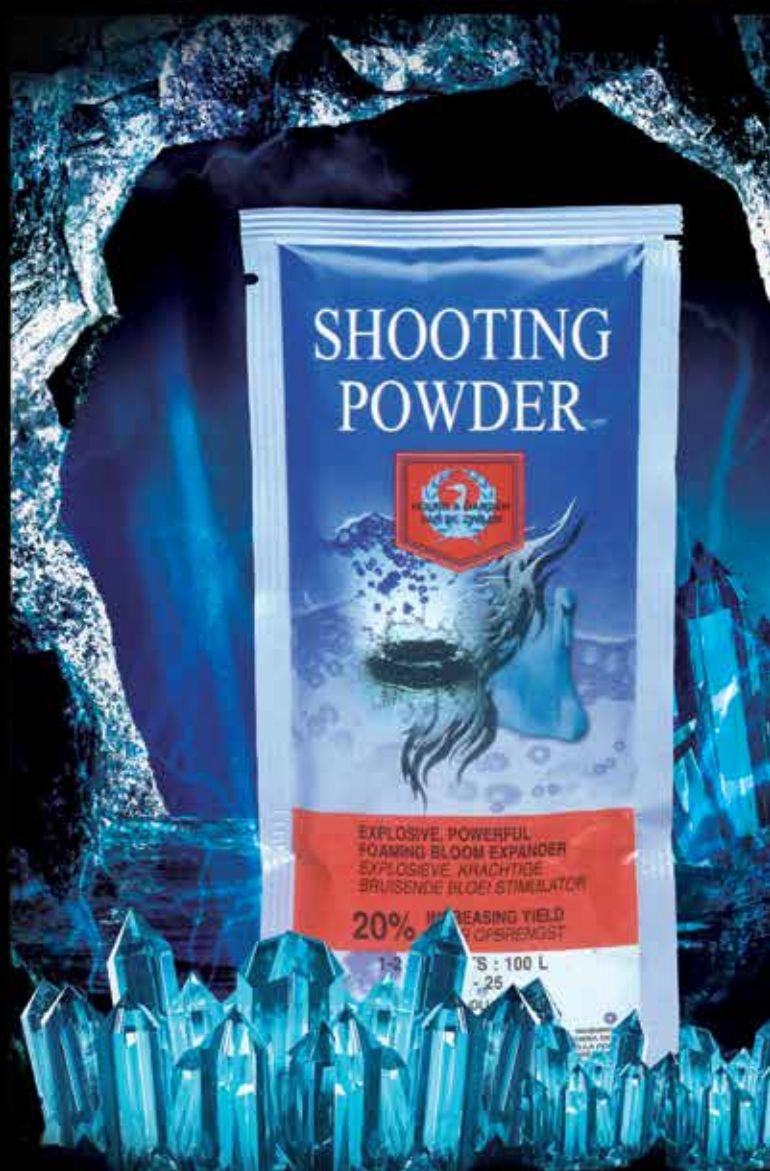

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THE 3 STAGES OF A PERPETUAL GARDEN

The most successful indoor growers take full advantage of the elevated degree of control over the growing environment hydroponics offers by maintaining a perpetual garden. This means establishing separate areas to meet the needs of plants during the three major stages of plant growth—the seedling, vegetative and flowering stages. Learn how to continually grow plants in each stage for constant harvests.

BY ERIC HOPPER

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When taking up indoor gardening as a hobby, many new growers are unaware of the need to separate plants during different stages of growth—I know I was. When I started growing indoors, I approached the process just like I approached outdoor gardening. I assumed annual plants would simply go through their life cycles if I gave them some soil, water and light. Although this is true, I quickly discovered that the most successful indoor growers take full advantage of the heightened control they have over the growing environment to maintain a perpetual garden.

To put it a different way, many growers establish separate areas to meet the needs of their plants during the three major stages of plant growth for annuals: the seedling and cloning stage, the vegetative stage and the flowering stage. By continually growing plants in each stage, a grower is constantly cycling seedlings or clones into the vegetative stage, moving vegetative plants into the flowering stage, and harvesting flowering plants once they mature. Understanding the required areas and the timing for each stage are the two biggest things a grower needs to master in terms of maintaining a three-stage, perpetual indoor garden.

"New growers should seriously consider some sort of environmental control for the seedling area."

SEEDLINGS AND CLONES

The seedling and clone cycle is the start of an annual plant's journey. Although it requires the least amount of space, it is the hardest stage to master because the atmospheric conditions within this area must be controlled and kept consistent. New growers should seriously consider some sort of environmental control for the seedling area. At this stage, most plants prefer warm temperatures (24-29°C) and high humidity (60-100 per cent). Seedling heat mats with thermostatic control, or temperature-controlled cloning machines, will help ensure these conditions are met. Light requirements for seedlings and clones can vary a little bit, but in most cases, a fluorescent T5 lighting fixture operating for 18-24 hours a day will suffice.

Clones taken from a mother plant take about two weeks to develop roots. Using this time frame, you can calculate when clones need to be taken so as not to interrupt the flow of the perpetual garden. Many growers will take clones when it's time to put other plants into the flowering room. And since most flowering plants take about eight weeks to mature, this will give the plants two weeks for root development, and six weeks for vegetative growth, before being cycled into the flowering room.

VEGETATIVE CYCLE

The vegetative cycle is the stage of growth when annual plants put on the majority of their green foliage. Annual plants in nature reproduce once a year and the vegetative stage is the stage that precedes the reproduction stage. Essentially, the vegetative stage is the plant preparing itself structurally for reproduction. This stage of growth requires more space than the seedling or cloning stage, but not as much space as the flowering stage. A good rule of thumb is to plan on a vegetative area that is half the size of the flowering area.

Plants in the vegetative stage should be given at least 40 W of artificial light per square foot of garden space. Although some old-school growers still stand by HID lights for this stage, I recommend using T5 fluorescents for vegetative growth because they

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provide better light distribution. When using an HID light for the vegetative stage, plants directly under the light will receive more light energy than those plants on the peripherals. To combat this, a grower has to either move the light or rotate their plants. With a T5 fluorescent fixture, the light is evenly dispersed due to the length of the bulbs. This means that, for the most part, plants can stay where they are without requiring rotation and man-handling.

Another advantage of T5 fluorescent lights is that they operate at a cooler temperature. Again, due to the length of the bulbs, the heat dissipates more evenly. There are some obvious advantages to a reduced heat load, including a reduction in operating costs. However, the biggest advantage of the reduced heat load is the plants can be placed closer to the light source, without fear of them being burned or damaged. Plants closer to the light source will naturally create tighter node-spacing (space between branches). This is especially advantageous when growing indoors because plants with more branches closer to the light source will have more flowers developing closer to the light source, equating to larger yields.

Other lighting technologies such as LEDs offer the same advantages as T5 fluorescents—think cooler operating temperatures and tighter node space development. Indoor gardening is all about maximising light energy, and plants that go through the vegetative stage under T5 fluorescents or LEDs will naturally make more effective use of the light energy in the flowering stage. The light cycle for the vegetative stage is usually 18-24 hours. I have always preferred an 18-hour light cycle, which gives my plants a little rest, but many successful growers swear by a 24-hour cycle.

One of the trickiest parts of managing a perpetual garden is knowing when to move clones or seedlings into the vegetative stage to allow them enough—but not too much—time in the vegetative stage. The best way to gauge this is to document the growth of a plant until it reaches the height desired for the flowering stage. With this information, make a calculation using the total duration of the flowering stage to determine the best time to start vegetative plants. For example, say you know your flower cycle takes eight weeks, and you have also determined that your vegetative plants reach the desired height in six weeks. To properly time your perpetual garden, you should start the vegetative growth stage two weeks after you begin each flowering cycle.

"The vegetative cycle is the stage of growth when annual plants put on the majority of their green foliage."

FLOWERING CYCLE

The flowering cycle is when all of the magic happens. Although it's the final stage, the flowering area of an indoor garden should be the one designed first since its size must be determined by the maximum light energy you are able to provide. For most annual plants, calculate 40-60 W per square foot of garden space.

"Although it's the final stage, the flowering area of an indoor garden should be the one designed first."

Once the size of the flowering stage has been determined, the sizes of the vegetative and seedling and cloning areas can also be determined. As mentioned earlier, since the plants in the vegetative stage will be about half the size of the mature plants in the flowering area, the vegetative area can be calculated as half of the area required for flowering. So if the flowering garden is 50 square feet, the vegetative space should be around 25 square feet.

One important consideration for the flowering area is light leaks. The photoperiod for the flowering room is 12 hours on and 12 hours off. Plants in the flowering stage must be kept completely dark during the lights-off period. Most annual plant are photosensitive, which means their stage of growth is determined by the amount of light and dark they receive in a 24-hour period. A flowering plant that accidentally receives light during the lights-off period could revert back to vegetative growth and this could severely diminish yields.

There are a few different light technologies that can be used during the flowering stage. HIDs, especially HPS lighting systems, are still the most popular choice, but in recent years, growers have been converting their systems to LEDs, plasmas and fluorescents for their flowering rooms.

Growers who are able to juggle three growing areas at once end up with a more productive garden overall. When calculating the production of a garden, it is best to consider how many harvests will occur during a one-year period. By keeping exclusive areas for the seedling or cloning stage and the vegetative stage, growers can continually move plants into their flowering room as they harvest. This perpetual style of growing is one of the biggest advantages of indoor gardening, as there is no down time.

The control over lighting and nutrients makes it easy for plants, regardless of which stage of growth they are in, to be grown in the same facility. All in all, designing growrooms with designated areas for the seedling, vegetative and flowering stages is the best way to make an indoor garden more productive and maximise your efforts. MY

When & How

TO TRANSPLANT SEEDLINGS INTO THE GARDEN

BY HEATHER RHOADES

Transplanting tender, young seedlings into your outdoor garden too early or too late can have dire consequences for those plants you so lovingly started from seed in your growroom. Luckily, we have both the when and the how.

Raising plants from seeds can be a rewarding and exciting way to add new varieties to your garden. Many of the best and unusual varieties of vegetables are simply not available in your local nursery and your only option is growing these plants from seeds. But to grow these unusual varieties, you must know something about planting seedlings.

HOW TO TRANSPLANT SEEDLINGS

One common question from people growing plants from seeds is, "How do I know when my seedlings are big enough to put out in my garden?" Planting seedlings out in the garden at the proper time is crucial to their development later on. If you put them out before they are ready, they may have a hard time surviving the elements. If you wait too long, your seedling may become root bound in its original container.

There is no hard and fast rule about how tall a plant should be before you put it out in the garden because different plants grow to different sizes. The amount of light a seedling gets can influence how quickly a plant grows when you are raising plants from seeds. If there is not enough light, a plant can grow tall very quickly, but this plant may or not be ready for planting out. The best way to judge if a plant is large enough to plant out in the garden is to look at the number of true leaves.

> "The best way to judge if a plant is large enough to plant out in the garden is to look at the number of true leaves."

TRUE LEAVES ON A SEEDLING

The general rule of thumb is that when a seedling has three to four true leaves, it is large enough to plant out in the garden (after it has been hardened off). When you plant a seed, the first leaves to emerge are the cotyledons. The purpose of these leaves is to provide stored food to the seedling for a short period of time.

True leaves grow shortly after the cotyledons. The true leave emerge and start generating energy through photosynthesis to help feed the plant for the rest of its life. Making sure that the plant has enough of these leaves to keep it sustained when planted out in your garden is important.

Just remember, it is not how tall, but how many true leaves your plant has that will determine when you should transplant seedlings. But even when your seeds are big enough to plant out, make sure you harden off your plants first.

HOW TO HARDEN OFF YOUR SEEDLINGS

When plants are grown from seed indoors, they are grown in a controlled environment. The temperature is usually maintained, the light is not as strong as full sunlight outside and environmental disturbances like wind and rain are non-existent.

Because a plant grown indoors has never been exposed to the harsher outdoor environment, they do not have defenses built up to help them deal with some of the environmental conditions found outside, similar to how someone who has spent all winter indoors will burn easily in summer sunlight.

The way to help your seedlings build up a resistance is to harden off your seedlings. Hardening off is an easy process and will make your plants grow better and stronger when you do plant them out into the garden.

STEPS FOR HARDENING OFF SEEDLINGS

Hardening off is really just gradually introducing your baby plants to the great outdoors. Once your seedlings are big enough to plant out and temperatures are appropriate for planting outside, pack your seedling in an open-top box to make transporting the plants easier.

Place the box of plants outside in a sheltered, preferably shaded, area. Leave the box there for a few hours and then bring the box back indoors before the evening. Repeat this process over the next few days, leaving the box in its sheltered, shaded spot for a little longer each day.

Once the box is outside for the entire day, move it to a sunny area and repeat the same process. For a few hours each day, move the box from the shaded area to the sunny area, increasing the length of time each day until the box is in full sun all day.

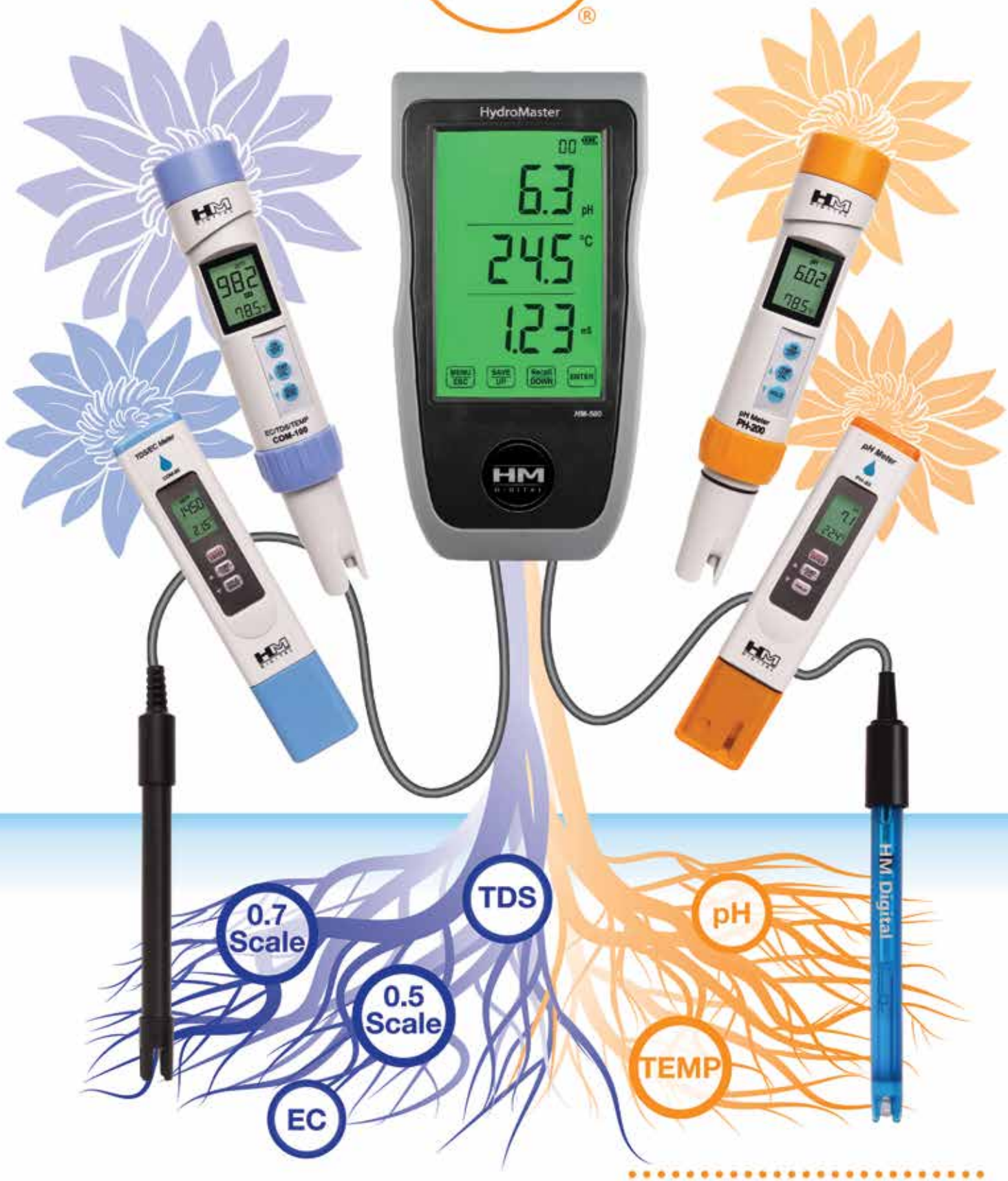
During hardening off process, it is best to bring the box in every night. Once the plants spend the whole day outside, then you will be able to leave them out at night. At this time, it will also be safe for you to plant the seedlings in your garden.

This whole process should take just a little longer than one week. Taking this one week to help your plants get used to the outdoors will help ensure your plants have a much easier time growing outside. MY

The Science Behind Companion Planting

By Frank Rauscher

Can't we all just get along? Companion planting is an important strategy in keeping gardens healthy without a lot of pesticides or labour. Knowing what plants are good neighbours is important, and the practice of using companions is beneficial. But have you ever wondered how it all works, and why some plants make good neighbours, while others should avoid living on the same street? Read on to learn the various ways plants help each other out as they grow up.



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Many curious gardeners will often find themselves wondering, "Is it OK to plant carrots with turnips, or some of these next to some of those?" Just receiving a simple yes or no answer doesn't really tell a gardener much, so with this article, I want to dive deeper and explain the science behind companion planting.

Growing two or more different plants in the same garden or container raises a few concerns. Will one or more of the plants interfere or compete with another? Will one plant provide benefits to the adjacent plants? Before making these determinations, you need to look into things like mutual climate co-operation, nurse cropping, trap cropping, symbiotic nitrogen fixation, biochemical pest suppression, attraction of beneficial insects and biodiversity. Phew! Let's look at how these work individually.

> "Peas, beans and other legumes have the ability to fix atmospheric nitrogen using small growths on their roots called nodules."

MUTUAL CLIMATE CO-OPERATION

Mutual climate co-operation refers to planting crops that, when they become full size, complement the needs of plants growing around them. A good example of this is planting tall, sun-loving plants alongside short, shade-tolerant plants. These combinations will help both plant types produce better yields, and also provides more pest control benefits overall.

NURSE CROPPING

A variation of mutual climate co-operation, nurse cropping refers to the use of annuals to protect perennials. Annuals are planted to help establish sun-tender perennials until they can handle the greater sun radiation or wind on their own. This same principle is applied when an annual is planted to reduce soil erosion, protecting the perennial's root system.

TRAP CROPPING

Trap cropping refers to the planting of a specific crop—a decoy plant—that will attract certain pests to itself, away from more valuable crops. For example, collards draw certain moths away from cabbage. This is different from creating a beneficial habitat in that one crop is essentially sacrificed to protect another. Another example of trap cropping is planting sunflowers along the perimeter of an outdoor garden to protect the smaller plants growing beneath them.

SYMBIOTIC NITROGEN FIXATION

Plants cannot survive without nitrogen, yet they cannot use it in the gas form abundant in air. Instead, living organisms use the ammonia form of nitrogen to manufacture the proteins and other nitrogen-containing nutrients needed to survive. Peas, beans and other legumes have the ability to fix atmospheric nitrogen using small growths on their roots called nodules. Within these nodules, nitrogen fixation is done by bacteria, and the ammonia form of nitrogen produced is absorbed by the plants, which can benefit neighbouring plants not capable of doing this. Plants that get nitrogen through symbiotic nitrogen fixation will require less nitrogen fertiliser.

BIOCHEMICAL PEST SUPPRESSION

Some plants exude chemicals that can protect neighbouring plants. For example, marigolds release thiopene, an aerial pest suppression that repels nematodes. In addition, some plants emit a pheromone that confuses male insects, causing them not to mate. Artemisia is great at repelling rabbits and other animals that are a nuisance to your garden. Make a border of it to discourage their presence.

Another form of biochemical suppression is a phenomenon called allelopathy. Allelopathy is a term used to describe the release of chemicals from the root system to discourage competition, and in some cases, insects. These chemicals can have a positive or negative influence on surrounding plants. Those that have a negative influence are an important part of other plants' defense, reproduction and growth systems. Lantana, for example, puts out chemicals that will reduce the spread and growth of various weeds. Broccoli is also allelopathic and deters the growth of other cruciferous crops around it, like cabbage, cauliflower and Brussels sprouts.

ATTRACTING BENEFICIAL INSECTS

Also known as habitat influence, this refers to neighbouring plants that attract various beneficial insects, predators and parasites that consume or destroy insects that might otherwise damage the protected crop. This strategy is used when the neighbouring plant lacks the ability to do so on its own. To determine what type of beneficial insects you want to attract, get an idea of what pest insects you are likely to encounter. Yarrow and dill attract ladybugs, and just about everyone knows how helpful these little creatures can be. Learn more about what these and other beneficial insects do to help in the garden, then do things that attract and keep them around.

BIODIVERSITY

Many insects and disease organisms prefer specific plant species. For example, the leaf-footed beetle sticks primarily to pomegranate trees, and horn worms adore tomatoes so much they are commonly called tomato worms. By mixing up your crop types, you are reducing the likelihood of a massive infestation that might come after a single dominant crop. If you want to know what crops are related to others, learn the botanical names of your plants. Knowing these Latin names will help you become more aware of which plants are similar, helping you increase the diversity in your garden. Attempt to use plants with different generas. For example, every kind of apple tree has the genus Malus. Their common names may seem diverse, but the plants are quite similar.

> "Broccoli is also allelopathic and deters the growth of other cruciferous crops around it, like cabbage, cauliflower and Brussels sprouts."

COMPANION PLANTING IN HYDROPONICS

When growing hydroponically, or with soilless media like clay pebbles, coco coir or stonewool, each plant tends to have its own container, unlike plants grown in a raised bed of soil. In this case, curious gardeners might wonder if companion planting is relevant. The answer is yes. For instance, if one plant's roots are putting out allelochemicals, these chemicals are likely to be getting into the recirculation tank, where they will later be exposed to other plants feeding from that same tank. Keep this in mind if you are recirculating your water.

There are many other influences from nearby plants besides allelopathy. Is your greenhouse or growroom completely free of insects? In most cases this is difficult or impractical to achieve and maintain. Even though you may be growing in a reasonably closed environment, you will probably find yourself dealing with insects. If you want your veggies to flower and set fruit, you will probably be wanting pollinating insects or you will be doing all the pollinating that needs to be done by yourself. So, here too, soilless gardeners will ultimately find that companion plants can provide many benefits in a controlled environment.

ADDITIONAL COMPANION PLANTS

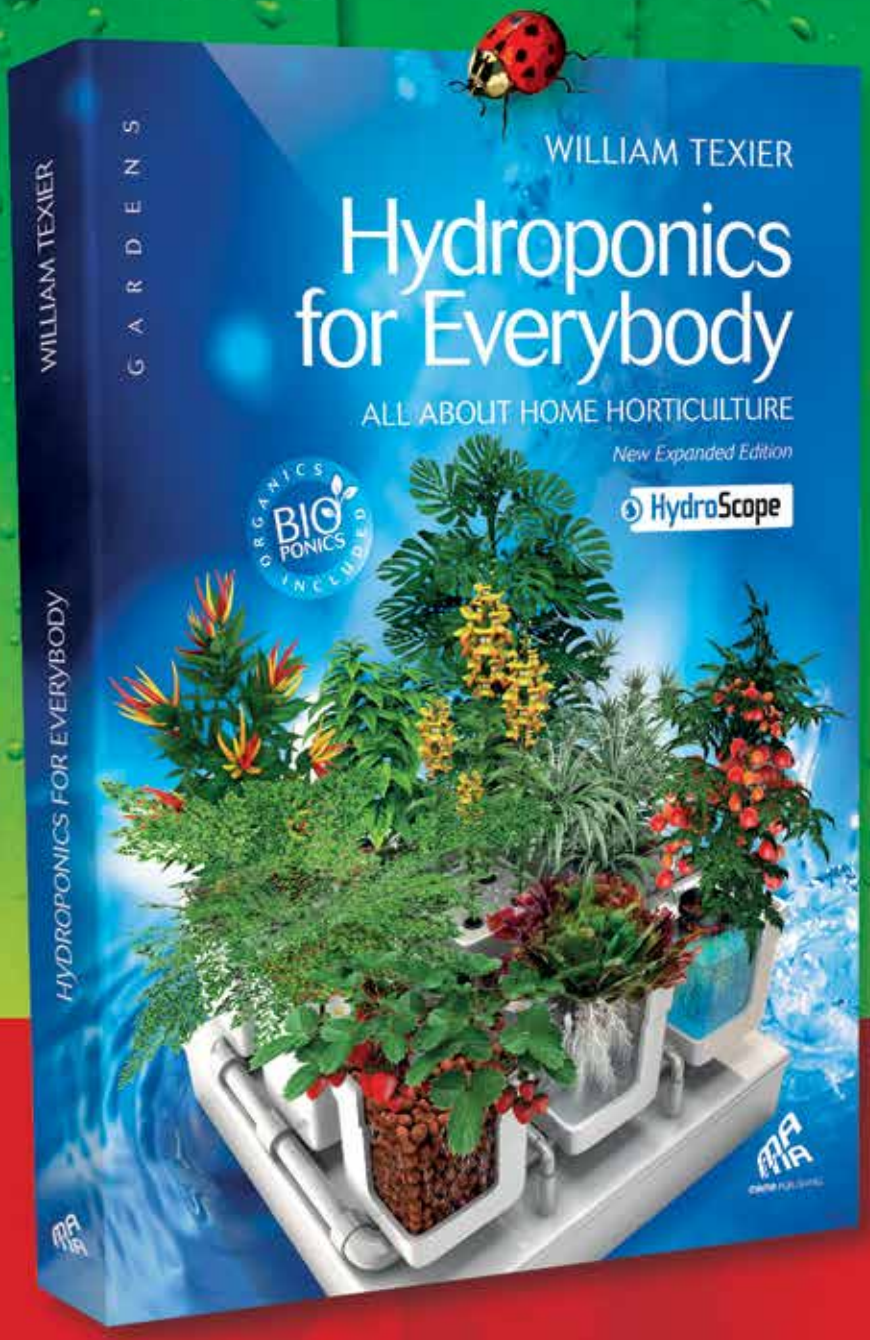
If you intend to grow tomatoes, consider basil a good neighbour. It will help deter flies, hornworms and mosquitoes. If you are growing carrots, use chives to chase away aphids, mites and nematodes. Marigolds are a great companion for most any plant as they discourage a number of damaging insects. Growing cabbage? Plant some mint nearby and keep the moths, aphids and beetles away. Also recall the traditional Three Sisters combination of corn, beans and squash. These three crops grow in perfect harmony.

> "If you intend to grow tomatoes, consider basil a good neighbour. It will help deter flies, hornworms and mosquitoes."

COMBINATIONS TO AVOID

There are some plants that won't get along, no matter how hard you try. If you're growing legumes, avoid planting onions or garlic in the same rooting area. Also, a rooting conflict will be likely if you plant sunflowers with potatoes. Corn and tomatoes are not going to get along well, either. Though the list of non-companions is rather short, learn more about plants that are allelopathic and apply that knowledge in your garden to avoid creating bad garden marriages.

Diversity is a great way to ensure your garden is healthy without having to do too much work or use too many pesticides. Understanding how one plant affects another can help you conduct more detailed research about the crops you intend to grow next. Agriculture is a science and you will find your future garden is much more successful when you continue to learn and take all of these things into consideration. MY



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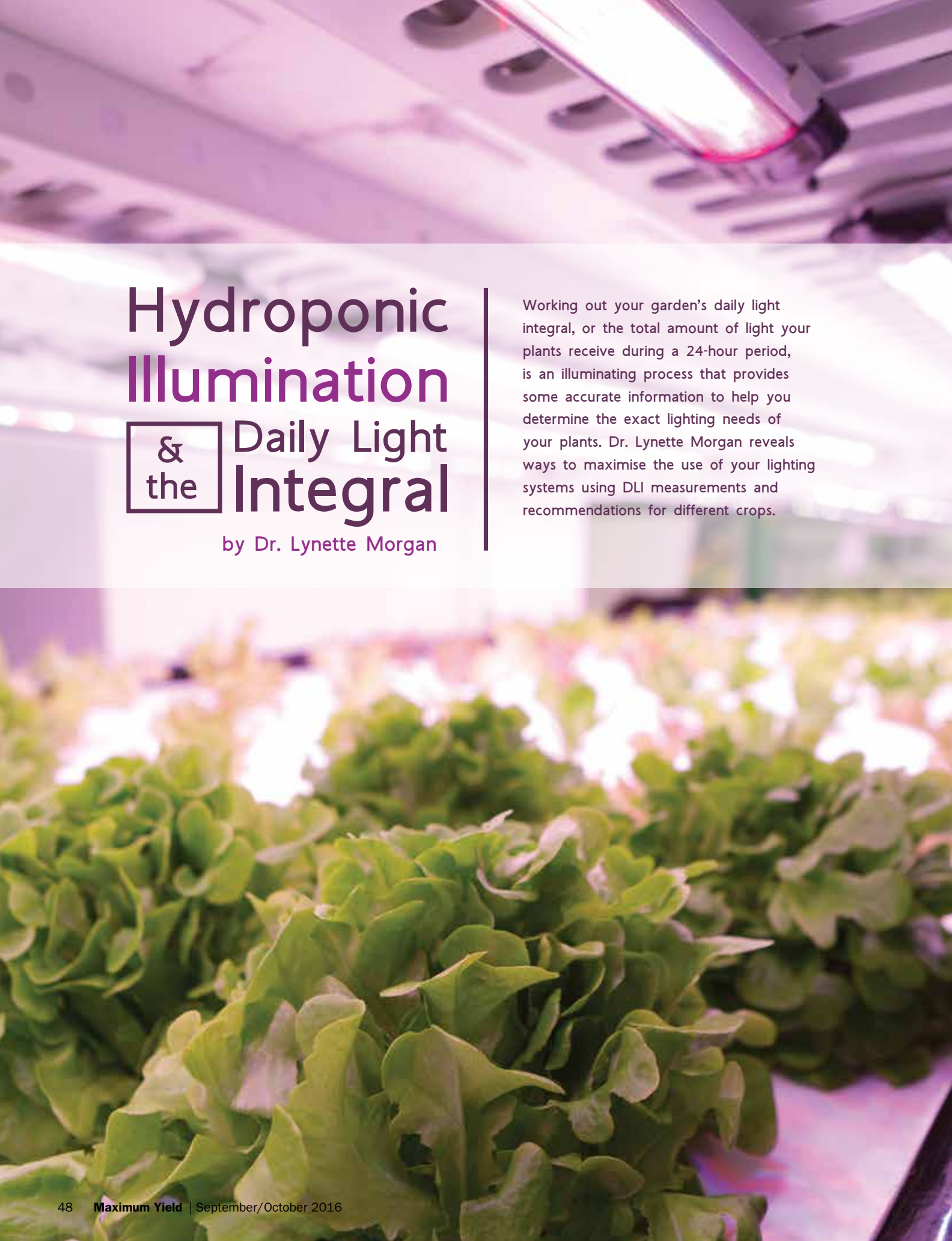
Hydroponic Illumination & the Daily Light Integral

by Dr. Lynette Morgan

Working out your garden's daily light integral, or the total amount of light your plants receive during a 24-hour period, is an illuminating process that provides some accurate information to help you determine the exact lighting needs of your plants. Dr. Lynette Morgan reveals ways to maximise the use of your lighting systems using DLI measurements and recommendations for different crops.



Many discussions about plant lighting for hydroponic systems are based on the lamp output required per unit of area, which is a good place to start, but it doesn't quite tell the full story when it comes to accurate plant illumination. A better way to determine your garden's lighting needs is to sort out the daily light integral (DLI) requirements of what you're growing.

DLI is not a complex idea, it simply refers to the total amount of light plants receive during a 24-hour period. It is a combination of not only the light intensity given off by the lamps, but also the duration of the light period. In an indoor garden, unlike many greenhouses, the amount, intensity and duration of lighting can be controlled and manipulated, and there are tools indoor growers can use to maximise plant quality using DLI measurements and recommendations for different crops.

Understanding the Daily Light Integral

A DLI measurement tells us how much plant-usable light the crop receives during a 24-hour period. It is expressed as photosynthetically active radiation (PAR) in the 400-700-nm wavelength range. If you compare this to the optimal DLI value for the crop being grown, it's possible to work out any light deficit that restricts growth and yields.

DLI is expressed as mol/m-2/day, which means moles of light (mol) per square metre (m-2) per day (d-1). A mole is a standard scientific unit used to measure a massive number of small entities, such as atoms—6.022x1023 to be exact. In other words, DLI refers to the number of light particles or photons plants receive in one square metre (10.8 square metre) of growing space in a day.

Many greenhouse growers use automated systems with sensors and computer controllers that calculate an area's DLI and graph the results. However, smaller-scale growers can make use of portable DLI monitors, which can be moved around the indoor garden to get an approximate reading for the DLI at the end of each 24-hour period. The DLI can also be calculated using hand-held light meters with some basic conversion factors for different types of lamps.

To get a handle on exactly what DLI refers to and how it relates to light intensity as we see it, it helps to visualise the natural light outdoors. For example, the DLI in the United States can vary from 2-60 mol/m-2 /d-1, depending on factors such as location and season. Outdoor winter light levels in temperate zones are typically much lower than is required for optimal greenhouse production of many common crops, while excessive light can cause problems in the summer. A dull winter's day with heavy cloud cover and a short day-length may see a DLI inside a greenhouse as low as 3 mol/m-2 /d-1. On the other hand, a bright, clear, sunny mid-summer's day with a long day length of 18 hours can create an average DLI of 35 mol/m-2/d-1 inside a greenhouse. Lower-light crops like lettuce require a DLI of 12-14 mol/m-2/d-1 for maximum growth rates, and higher-light crops such as tomatoes require at least an average DLI of 22 mol/m-2/d-1 or up to 30 mol/m-2 /d-1 to reach light saturation at maturity.

Greenhouse growers often aim for a target minimum DLI of 10-12 mol/m-2/day for maximum year-round production, with those in lower light climates often making use of supplementary lighting to increase the natural light up to these levels. In an indoor garden, where artificial lighting is the

Left: Mature tomato plants have one of the highest DLI requirements of all hydroponic crops.

Right: Vertical systems have a higher DLI requirement than single-layer systems to ensure all plants receive sufficient light.

> "DLI is not a complex idea, it simply refers to the total amount of light plants receive during a 24-hour period."

Left: Mixed-species systems require careful plant positioning based on light requirements.

Right: Butterhead lettuce has a minimum DLI requirement of around 14-16 mol/m-2/day.

> "Many greenhouse growers use automated systems with sensors and computer controllers that calculate an area's DLI and graph the results."

only source of illumination, illumination can be more highly controlled and adjusted as required for the different stages of growth.

Light Measurement

Measuring light in an indoor garden over a 24-hour period may seem like a relatively simple process. After all, lamps provide the same output each hour of the day they are switched on. This is unlike natural light, which varies considerably over the course of a day and is also weather-dependant. However, while the lamp output remains the same, at any one time there are usually light variations within an indoor garden based on factors such as plant distance from the lighting source, the impact of reflectors and reflective surfaces, the overlapping of adjoining lamps, and the shading and density of plants.

When measuring light indoors, the most accurate data can be obtained by taking readings in a number of locations around the system. This process not only allows growers to check to see where the lower light positions are, but helps growers know where to place lamps so lighting is as uniform as possible within the indoor garden. Light should always be measured at canopy height, which is just at or slightly above the top leaves of the plants. Obtaining a few other readings just inside the canopy is also worth doing to see how much light is reaching the foliage further down in the crop or where smaller plants might be sited.

How to Calculate the Daily Light Integral

The DLI for an indoor growroom can be calculated based on readings from a hand-held light meter that records PAR in micromole/m-2, or in foot candles, the more old-fashioned unit.

Steps for using a foot candle meter:

1. Take and record the foot candle light reading in a single position at canopy height. Repeat this process for different positions around the indoor garden if light is not uniform.

2. Multiply the foot candle reading by the number of hours the lights are on in each 24-hour period. For example:

1,200 foot candles x 14 hours = 16,800

Divide this by 24 hours = 700 foot candles per hour

Using the equation 700 x 0.15* converts this to 105 micromoles PAR. Finally, 105 x 0.0864** gives a DLI of 9 mol/m-2/d-1.

* The metal-halide (MH) conversion factor used in this calculation varies for different light sources. Sunlight has a conversion factor of 0.2, high-pressure sodium (HPS) lamps have a conversion factor of 0.13, MH lamps have a conversion factor of 0.15, LEDs have a conversion factor of 0.13 and cool white fluorescent lamps have a conversion factor of 0.13.

** The 0.0864 factor is the total number of seconds in a day divided by 1,000,000.

Once the DLI for an indoor garden has been calculated, it is possible to compare this to the optimal level for the types of plants being grown and adjust light levels as required. For plants that have specific day-length requirements for flower initiation, it may not be possible to simply extend the number of hours the lights are run to increase the DLI to more optimal levels. In this case, the only option is to increase light intensity by installing more lamps if the DLI needs to be increased to maximise growth.

For other plants that are not day-length sensitive, a low DLI can be improved by increasing the number of hours the lamps are run for in each 24-hour period. Longer hours means more photons of light are received by the plants for growth and development. In a mixed-crop system, where high- and low-light plants are growing in the same system, providing the ideal DLI becomes more of a compromise. In this case, positioning the higher-light plants directly under the lamps and the lower-light plants further away from the light source can help maximise photosynthesis across the indoor garden.

Light Requirements for Different Crops

The DLI has a significant impact on a number of plant variables, including root and shoot growth, stem thickness, plant height, branching, flower amount and flowering timing. All of these factors have a big impact on yields and overall crop quality.

- For propagating seedlings and many young cuttings, a low DLI of 6-8 mol/m-2/day is recommended, which should increase to 10-12 mol/m-2/day for older transplants, flowering annuals and small herbs.
- Many shade-loving indoor plants and ornamentals require a relatively low DLI. African violets and Phalaenopsis orchids prefer an average DLI of 4-6 mol/m-2/day.
- Many ferns perform best at a DLI of 4-6, cyclamen at 6-8, fuchsias at 10-12, chrysanthemums at 10-14, petunia at 16-18 and cut-flower rose plants at 18-22 mol/m-2/day.
- For butterhead lettuce production, plants need a DLI of approximately 14-16 mol/m-2/day for high-quality head formation, while iceberg lettuce requires even higher levels.
- Larger, warm-season plants such as tomatoes, cucumbers, capsicums and eggplants require DLIs of 20-30 mol/m-2/day for maximum production. The actual optimal light levels depend on density.
- Higher-density crops produce more interplant shading and require a higher DLI to completely penetrate the thick canopy.

The Effects of Low DLI

Low light has a number of negative effects on many plants, the most significant one being slow growth and lower production levels. However, a low DLI for high-light vine crops such as tomatoes also restricts fruit quality in terms of sugar content, dry weight and flavour. If the DLI falls particularly low, flower and fruitlet drop may occur, as the plants can't produce enough assimilate for reproductive growth. Plants under low light may also become unbalanced, with tall, weak, thin or excessive vegetative growth, delayed flowering and minimal fruit set and growth.

If a low DLI is combined with warm growing conditions, many plants such as lettuce, herbs and many other vegetative plants, may develop physiological disorders like bolting. This is characterised by elongated growth and the development of a flowering stem while plants are still relatively young. Low light can also weaken foliage, making plants more susceptible to a number of disease pathogens.

Knowing an indoor garden's DLI gives growers the flexibility of strategically placing different types of plants within their hydro system, according to their different lighting requirements. The well-thought-out placement of the plants ensures that sufficient light—delivered through a combination of illumination intensity and day length—is provided for each crop and each stage of growth to achieve maximum yields and quality. For an online DLI calculator, visit *extension.unh.edu.* MY

> "For plants that have specific day-length requirements for flower initiation, it may not be possible to simply extend the number of hours the lights are run to increase the DLI to more optimal levels."

Left: Some plants have specific day-length requirements that need to be taken into consideration when it comes to DLI.

Right: Low light and warm temperatures can lead to problems such as bolting in lettuce and other plants.

SYSTEMIC AND NON-SYSTEMIC PESTICIDES

by Rich Hamilton

No grower wants pests in their garden, but how they are dealt with can have varying consequences on plant health, your health and the environment. Rich Hamilton provides some insight on making the right choice when it comes to pesticides.

There is a lot of information out there telling you how to get rid of pests in a hydroponic garden, which pests are the worst, which are most common and what to do about them and when. I can't, however, find anything that tells you what types of pesticides there are, how they affect the plant, how they work and if they can have any ill effects on the plants, the yields or even human health. Considering I consume what I grow, as I'm sure you do as well, trying to cure one problem might inadvertently create another one, possibly a much bigger one that could affect our long-term health.

WHAT DOES SYSTEMIC MEAN?

The definition of systemic is something that spreads throughout and effects something as a whole, in this case we are talking about a plant. The general rule of thumb in hydroponics and indoor gardening is that non-systemic pesticides are okay and systemic are not. Why?

Non-systemic pesticides are thought to be okay as they can be removed/flushed from the plant before harvest. This makes the produce from the plant clean from pesticide chemical tainting and thus better for human consumption.

Systemic pesticides are thought to be unsuitable as they affect the plant as a whole. Whether they are taken up via the roots or from absorption through spraying the leaves, pesticide chemicals cannot be removed/flushed from the plant. Once they have been taken in by any part of the plant they are present in and affect it as a whole. Systemic pesticide chemicals designed to kill insects will be present in the plant's flowers, fruits and seeds, essentially poisoning them.

Most systemic pesticides used in hydroponic growing are hazardous to humans, so once used on a plant, that

plant and anything that plant produces (including seeds) will not be fit for human consumption. Some of the chemicals are known to cause, amongst other things, cancer, birth defects and sperm mutation. Also, it affects the pollen of the plant. This has had a huge negative effect on pollinator populations with bees being a prime example. Systemic man-made pesticides have diminished bee populations to critical numbers around the globe.

There are three main common groups of pesticides that are used in hydroponics and indoor gardens:

- Contact pesticides - mainly non-systemic
- Surface pesticides - mainly non-systemic
- Uptake pesticides - mainly systemic

All of these can be either systemic or non-systemic, however, normally they fall under the above categories. Unless you ask at the purchase point you won't know. If you do ask and the sales associate doesn't know or is not sure, my advice would be to hold off until you know for sure. Pesticides can be dangerous and the bottom line is it is important the retailer provides you with accurate and timely information about the product.

Contact pesticides. These types of pesticides are designed to be sprayed or applied directly to the unwanted pests. This contact is where it will have the necessary results on the pest. These pesticides are designed to kill pests on contact, and there doesn't appear much thought has been put into the effects the excess spray that ends up on your plants may have. Contact pesticides are normally non-systemic but can be systemic. Excess spray can be absorbed by the plant through the leaves and the stem where it will remain in the tissue of the plant. Contact pesticides are normally pretty harsh stuff. They can leave a chemical taste in the fruit of the plant if applied while the plant is flowering/fruiting.

"THE GENERAL RULE OF THUMB IN HYDROPONICS AND INDOOR GARDENING IS THAT NON-SYSTEMIC PESTICIDES ARE OKAY AND SYSTEMIC ARE NOT."

Surface pesticides. This is where the plants are treated with the chemical pesticide (normally via a spray). The chemical coats the plant surface and kills the insect from the insect having contact (whether that be the pest eating thought the pesticide to get to the plant or simply walking over the treated surface) with the affected area or forming a repellent/barrier between the plant and the pest. Again, these pesticides aren't designed to be taken into the plant systemically but nevertheless some do, as prolonged surface exposure to the chemical and the plant is common. This is especially true with indoor gardening and hydroponics as there tends not to be any rain, which would in a natural outdoors environment help to clean the plant of any surface pesticide chemicals.

Uptake pesticides. These pesticides are nearly always systemic. They are called uptake pesticides because the pests take up the pesticide directly from the plant. These pesticides are normally fed to the plant viscerally, but they can also be applied via a spray. The premise of this type of pesticide is that they are systemically taken in to the whole of the plant, essentially turning the plant poisonous to the pests that are feeding off them. As mentioned previously, this not only poisons the main plant but also poisons its fruits, seeds, leaves and even the pollen. The long-term consequences are toxic soil and any run-off through the irrigation system will negatively affect the environment and be harmful to creatures. The discarded portions of the plant, some of which are used to feed livestock, tilled back into the soil or composted will also carry a toxic signature.

WHAT'S THE BOTTOM LINE?

Every grower will have pests at some point and what you do about them is up to you. If you do decide to use pesticides, consider their effects on the plant's health, your health and the environment's health, and consider less harmful options that can perform the same task. Hopefully this information will help you to make an informed and responsible choice when buying pesticides. MY

Rich Hamilton has been in the hydroponics industry for more than 20 years, working originally as a general manager in a hydroponics retail outlet before becoming an account manager at Century Growsystems. He enjoys working on a daily basis with shop owners, manufacturers, distributors and end users to develop premium products.

TOP 10 REASONS TO TRY AQUAPONICS

by Jeremiah Robinson

Aquaponics, a growing system that combines raising fish with growing plants hydroponically, is becoming increasingly popular amongst organic gardening enthusiasts. Thinking of trying it out for yourself? Here are 10 benefits that will help motivate you to get your own fish and veggie production system going.

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I talk to a lot of people about backyard aquaponics through my blog, at workshops and on forums. We are a bunch of characters, let me tell you! Whether urban, suburban or rural, the creativity and resourcefulness of the aquapons I meet constantly inspires me. Each of us tells a different story about what piqued our interest in this fun and fascinating hobby, but some common themes run through many of our stories. Here I share the top 10 reasons I've heard, in no particular order.

10. HEALTHY, FRESH, TASTY, ORGANIC GREENS

When I come home from work, I drop off my bags, pick spinach and five kinds of lettuce, and eat a salad. If you design your system right and manage to avoid insects, you don't need to wash your greens. I do this in all four seasons. If you've never tasted a five-minute salad made from five kinds of lettuce, I highly recommend it!

In recent years, folks like Joel Salatin, Michael Pollan and the dirty dozen campaign have expounded on the risks associated with eating pesticides and herbicides every day. Any poison, including most organic pesticides and herbicides, would kill your fish and wreck your system. Simply put, aquaponics = no poison.

Beyond the health and safety concerns, shipping produce around the world uses epic amounts of non-renewable resources. For instance, the average store-bought tomato burns about a tablespoon of gasoline on its way to you. Products shipped around the world also require a certain shape, size and texture to pack and ship well. Breeding vegetables for these characteristics sacrifices taste. Anyone who's ever eaten a farmers' market tomato can vouch for this.

> "AQUAPONIC SYSTEMS CAN BE DESIGNED TO ENSURE YOU NEVER HAVE TO BEND OVER TO PLANT OR HARVEST."

9. HEALTHY, FRESH, TASTY, ORGANIC FISH

Three things improve the taste and texture of fish:

- Two days in clean, cold water
- Four days without feed
- Eating it extremely fresh (within an hour of harvest)

When I make a fish dinner, the fish part of the meal takes 20 minutes, including harvesting. Time waiting in line at the grocery store? Zero minutes. Much of our farmed fish comes from China. Remember that Chinese baby formula scandal? If Chinese companies include toxic chemicals in their baby food, imagine what they put in their fish food. Simply put, be your own fish farmer.

8. EASY ON THE BACK

Many older people love to garden, but let's face it, as we grow old, our backs turn to rubble. Gardening is hard on the back. Aquaponic systems can be designed to ensure you never have to bend over to plant or harvest.

7. LOWER CHOLESTEROL LEVELS

You: Doctor, what should I eat to lower my risk of heart disease?

Doctor: Stay away from saturated fat, processed sugars, high-glucose wheat and chemicals.

You: But then what can I eat?

Doctor: Lots of greens and fish.

You: So you're saying I should do aquaponics?

Doctor: Yes.

6. INCREASED SELF-SUFFICIENCY

We live in a volatile world. Stuff can go wrong, sometimes really wrong. Local grocery stores contain enough food to feed your community for three days. Beyond that, you're on your own. You don't need to be a prepper to take reasonable precautions against disasters, whether natural or man-made.

5. COST-EFFECTIVE FOOD PRODUCTION

I've done the math. A home-built, backyard-scale, cold-weather aquaponic system costs about $800. Expenses (electricity, fish and feed) add up to about $400/year. Each year, an aquaponic system grows food that, when sold at a farmers' market, would bring in about $1,300. That's $900 in net savings per year. That's a darn good investment.

4. A CHANCE TO TINKER

This is optional. A professionally built system with a controller and a maintenance contract run according to the advice of an experienced aquapon requires zero tinkering. It just works. But many of us like to make improvements and try new things. We try new plants, new fish, new control strategies, new gadgets. For us, it's fun! If you like to tinker, aquaponics is heaven.

3. A SENSE OF COMMUNITY

A few times a week, I come home to a half-dozen neighbourhood kids asking to feed my fish and do the water-testing experiments. Other days, adult neighbours stop by for lettuce and leave money in the can. Once I set up an aquaponic system, my little homestead became a hub of neighbourhood activity, and I love it! Now my neighbours all know me. Even better, they know each other. The kids all love my greens and are learning how to raise their own healthy food.

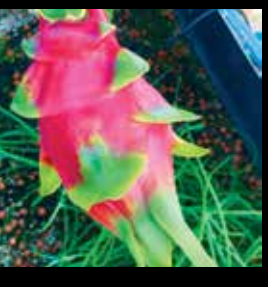
> "A PROFESSIONALLY BUILT SYSTEM WITH A CONTROLLER AND A MAINTENANCE CONTRACT RUN ACCORDING TO THE ADVICE OF AN EXPERIENCED AQUAPON REQUIRES ZERO TINKERING."

2. FREE THERAPY

When you walk into a warm, sunny, lush greenhouse filled with growing plants and excited fish, it lifts your spirits out of the dark. Social science tells us that in the face of seemingly insurmountable social and environmental problems, doing something meaningful takes us from a place of fear to a place of hope. Feeling overwhelmed by all that seems wrong in the world? Do something. Do aquaponics!

1. WARM, INVITING SPACES

Many aquaponic greenhouses are Spartan affairs with little space for leisure or enjoyment. Mine is. But many folks with more foresight than me designed theirs for pleasure and aesthetic beauty, in addition to production. My next greenhouse will include a Zen garden, wood stove, comfortable table and chairs, and a hot tub that drains into the aquaponic system when we're done. Where better to spend a Friday night than relaxing with your friends and your fish? MY



AQUAPONICS WA

FROM A BUSINESS THAT STARTED IN A SMALL SHED TO WESTERN AUSTRALIA'S LARGEST HYDROPONIC AND AQUAPONICS RETAILER, AQUAPONICS WA AND HYDROPONIC XPRESS ARE ON THE VERGE OF A LANDMARK OCCASION WITH THE GRAND OPENING OF ANOTHER EXPANSION ON SEPTEMBER 10. ERICA ROBERTS EXPLAINS HER PARENTS' JOURNEY, THEIR SUCCESS IN BUSINESS AND THE STRENGTH OF FAMILY.

"ANSWERS FROM THE PROFESSIONALS."

After trying with little success to grow vegetables in gutless grey sand, Delia van Aurich was inspired after attending a hydroponics party plan in 1985 to grow food this new way. She and her now late husband Robert virtually dropped everything and opened their own hydroponics business, Aquaponics WA, the following year.

The beginnings were humble; Delia and Robert initially operated the business out of a small shed. They were determined to succeed, however, and took night school courses to obtain their trade Certificate in Horticulture to gain as much knowledge as possible. The consummate perfectionist, Robert was soon offered a job at the university and lectured in the horticulture department for many years while Delia focused on getting the business off the ground.

"Both Robert and Delia worked tirelessly and became leaders in the commercial and retail hydroponic industry," says Erica Roberts, their daughter and current advertising and accounts manager for Aquaponics WA. "The struggle of starting a new business with limited cash flow meant that mum and dad became a free source of information to anybody who showed an interest. So not only were demonstrations set up in shopping centres, but commercial growers came

to learn how to grow vegetable crops in this new way," she says.

For years, Robert and Delia worked long hours, seven days a week. Over time, the effort began to pay off. They moved to a larger site with better exposure and the business gained traction. In fact, it is the same facility in the Canning Vale area of Perth where Hydroponic Xpress is located today.

"The area of Canning Vale has continued to grow and allowed us to enjoy major exposure with high traffic volumes nearby every day," says Erica. Over time, Aquaponics WA grew as well, expanding with increased inventory and expanded staff. The Canning Vale site of Hydroponic Xpress and Aquaponics WA now consists of several buildings with a sum total of more than 1,000 square metres of retail and warehouse space, plus more than 1,000 square metres of greenhouse and display area. Erica says customers are often overwhelmed by the size and scope of the business.

In 2011, Robert became ill and passed away. Delia wasn't left alone. As a young man, their son Maurice obtained his Bachelor of Business at Curtin University and moved to Sydney, accepting a job offer from Kodak Australia. He worked and lived there for five years before marrying and moving back to Perth to join the family business in 1996. Today, Maurice manages purchasing and marketing, successfully landing Bunnings WA as a core customer. Erica started in her role in 2007, and Erica's daughter, Maggie, works part-time in customer service and administration while working toward a Diploma in Business Commerce at Curtin University.

Together, they continued to grow the business with 10 employees and the largest selection of nutrients, additives, fans, filters, grow tents, aquaponics trays and tanks, pumps, filters and lighting in Western Australia.

"Our shop is the largest in Perth and we have a strong online presence and strive to stay current with the latest technology," says Erica. "We have staff that are knowledgeable and friendly and are always willing to help our customers and connect with them."

Along with the family members, Mike is the floor sales manager, Tara is the weekend floor sales manager, Rob Sr. is warehouse manager assisted by Andrea, and Rob Jr. is the sales assistant and is in charge of the aquaponics display. Brian is the company's all-around handyman and performs deliveries. He also works in the display centre and brings invaluable knowledge of aquaponics to the team.

"We couldn't do without any of them,' says Erica. "Each and every one of our staff play a pivotal role in helping make Aquaponics WA and Hydroponic Xpress a success. Our team share a love of gardening and fish and we all share a passion for environmental success for now and future generations."

Also contributing are seven massive 50-centimetre barramundi that people love to visit. During a newspaper photoshoot, the fish managed to soak Erica and Maurice head to foot. "We finally got the perfect shot, but we both ended up soaked," she says.

In 2005, Delia was nominated for The 2005 Prime Minister's Employer of the Year Award, a prestigious event held in Canberra to recognise excellence in the employment of people with a disability.

Through ups and downs, hard work and times of laughter, the team at Aquaponics WA and Hydroponic Xpress continue to move forward. They have just completed a $500,000 expansion with the intent of educating even more people on aquaponics and hydroponics and in the future have plans to refurbish the display centre that may incorporate a massive aquarium to hold the big barramundi.

To celebrate the expansion, the team at Aquaponics WA is hosting an Open Day on September 10, 2016. Members of the public, schools, churches, local businesses and dignitaries are welcome to attend. The event will feature prizes, demonstrations as well as free hot dogs and refreshments. MY

"WE ALL SHARE A PASSION FOR ENVIRONMENTAL SUCCESS FOR NOW AND FUTURE GENERATIONS."

Phone: +61 8 9455 2133
Web: *www.info@hydroponicxpress.com.au*
Email: *info@hydroponicxpress.com.au*

MAXIMUM YIELD DISTRIBUTORS

Retail stores listed alphabetically state.

Interested in carrying Maximum Yield *in your store? Distribution is available by contacting Dome Garden Supply, Holland Forge, House & Garden, Growlush, Hydroponic Generations, Plant Symbionts, and Way to Grow. Already a distributor?* ***Call 1-250-729-2677 to update your listing.***

AUSTRALIA 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 Drive,
Nulkaba NSW 2325
(02) 4990 4291
admin@simplydvine.com.au

99 Trading
57 Hoskins Avenue, Banks Town
NSW 2200
(02) 9790 1525

ABC Aquaculture
54 Wahroonga Rd.
Kanwal NSW 2259
(61) 2 4393 3131

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

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

Ballina Hydro
3 Ray O'Niell Cres.
Ballina NSW 2478
(02) 6686 7321

Criscete Hydroponics and Organics
Unit 2/15 Kam Close
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 CorporationCircuit, Tweed
Heads South NSW 2486
(07) 5523 9565
earthandcolour.com.au

Ezi Grow Hydro
Unit 3/84 Bills Line of Road
North Richmond NSW 2754
(02) 4588 5826

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

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

Hong Hung
D5 303 The Horsley Drive,
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
0414 609 241

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) 427 48001
warrawonghydro@hotmail.com

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

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

NORTHERN TERRITORY

Darwin Hydroponics
5/8 Andrews St, Berrimah NT 0828
0478 735 165
darwinhydroponics.com

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

A Happy Medium Hydroponics
Unit2/10 Central Crt.
Browns Plains QLD 4118
(07) 3809 3322

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
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 Drive
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

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 PDE
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
31 Casey St.
Aitkenvale QLD 4814
(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 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

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) 82682636

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, S.A 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
Factory 39 / 148 Chesterville Rd.
Cheltenham Vic 3192
(03) 9555 0228

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

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Hallam Vic 3803
(03) 9796 3776

Central Hydro
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Bundoora VIC 3083
(03) 9466 7635
centralhydroponics.com.au

Chronic Hydroponics
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Templestowe Vic 3106
(03) 9646 8133

Complete Garden Supplies
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Sunshine Vic 3020
(03) 9311 9776

Crown Garden Supplies
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Hillside VIC 3037
045 996 6344

Discount Hydroponics
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Doveton Vic 3177
(03) 9792 2966

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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

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Preston Vic 3072
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Windsor Vic 3181
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Ballarat, Vic 3350
(03) 5338 7555

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Braeside Vic 3195
(03) 9701 8811

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Sunshine Vic 3020
(03) 9356 9400

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Traralgon Vic 3844
(03) 5176 0898

Greenleaf Hydroponics
Factory 7, Industrial Park Dr.
Lilydale Vic 3140
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GreenLite - Ringwood
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Ringwood Vic 3134
(03) 9870 8566

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Greensborough Vic 3088
(03) 9435 6425

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Springvale Vic, 3171
(03) 9546 9688
www.growlush.com

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Moorabbin VIC 3189
(03) 9912 6090
guerrillagardens.com

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Rowville Vic 3178
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Airport West 3042
(03) 9331 5452

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4/19 Jersey Rd.
Bayswater Vic 3153
(03) 9720 1946

Hyalite Global
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Sunshine North Vic 3020
(03) 9356 9400

Hyalite Westend
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Sunshine Vic 3020
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Hydroponic Central
110 Dynon Rd.
West Melbourne Vic 3003
(03) 9376 0447

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VIC 3061
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Collingwood Vic 3066
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Thornbury Vic 3071
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Salisbury Downs 5108
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Murrumbeena Vic 3163
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Deer Park Vic 3023
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justhydroponics.com.au

Just Hydroponics Factory
39 Westwood Dr.
Ravenhall VIC 3023
(03) 8390 0861
justhydroponics.com.au

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Hoppers Crossing Vic 3029
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justhydroponics.com.au

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(03) 5133 9140

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Footscray West Vic 3012
(03) 9314 0055

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(03) 8712 2421

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Mc Crae VIC 3938
(03) 5981 1160

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Melton Vic 3194
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Wendouree Vic 3355
(03) 5339 1300

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West Melbourne VIC 3003
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mirrorpaints.com.au

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Hoppers Cros. Vic 3029
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Boronia Vic 3155
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Knoxfield VIC 3180
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Canning Vale WA 6155
1800 640 222

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Bunbury WA 6230
(08) 9721 8322

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Maddington WA 6109
(08) 9452 0546

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Tuart Hill WA 6060
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Albany WA 6330
(08) 9841 3220

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(08) 6461 6816
hydrohill.com.au

Hydro Nation
41A Rockingham Rd.
Hamilton Hill WA 6163
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Malaga WA 6090
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reptileandgrow.com

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New Plymouth
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Dunedin
(03) 456 1980

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Glenfield
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Hyalite Hamilton
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West Hastings
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Henderson
(09) 837 1210

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(09) 263 4336

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Tauranga
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