

CANNAtalk[®]

MAGAZINE FOR SERIOUS GROWERS

ISSUE 39 2021

LIGHT Absorption

The effect of color



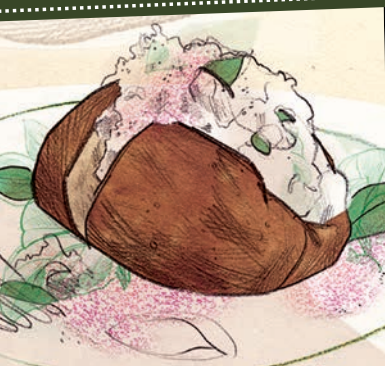
VERTICAL FARMING

The sky's the limit



The terrible TATER

Grow it yourself



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The solution for growth and bloom

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Grower's Tip

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Questions & Answers

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Perfected through experience



HOTalk:

Years ago, when my son needed to do a science project for school, I suggested that he try growing plants using different light spectrums. The setup was simple but colorful. He had red, blue, green, yellow, and white bulbs divided up and hung over test plants. At night time, his room would glow with colorful light leaking out of his grow tent. Throw a little James Brown on his blue tooth speakers, and he would have had a little 70's disco club in his mini garden! The science project results came out as expected, with each plant having noticeably different growth patterns. Although he didn't win the grand prize for his project, he did have the most entertaining display (disco music included of course!) and he was able to showcase how important types of light are to the growth of plants.

Little did we know that this small experiment would be showcasing many of the questions we still ask about horticultural lighting today. What truly is the best lighting for optimal plant health? What spectrums have the greatest effect on the plants we are growing? Does James Brown music make gardens funkier than disco? All jokes aside, there has been plenty of chatter about new advanced lighting systems for plant production coming into the market. Some are old reliable technologies that have been improved upon. Others are so innovative that they are truly shedding new light on the future possibilities for high intensity horticulture. This issue of CANNATalk attempts to examine all facets of this most important element. By breaking down the basic terms that define "light" growers will have a solid foundation to dive deeper into illuminating its most essential role in plant health. We take a closer look at light absorption and the effects of wavelength while highlighting various lighting systems available to growers. Last but not least, we address LED technology and the factors we must consider when switching to this new powerful garden upgrade. It is safe to say that this issue will be shining new light on a subject that old and new growers can appreciate!! Better bring some shades!!

Enjoy!

David "Disco Tent" Hill

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LIGHT ABSORPTION

AND COLOR DEPENDENT PLANT INTERACTIONS

GROWERS HAVE OPTIONS WHEN IT COMES TO LIGHTING CHOICE AND HAVING A GOOD UNDERSTANDING OF LIGHT CONCEPTS IS KEY FOR MAKING THE BEST DECISIONS. LET'S SHINE SOME LIGHT ON FUNDAMENTAL TERMINOLOGY, PLANT-LIGHT INTERACTIONS, AND THE EFFECT OF DIFFERENT COLORS SO THAT NEXT TIME YOU ADMIRE YOUR ILLUMINATED PLANTS, YOU'LL BE GETTING A DEEPER VIEW.

By Abha Gupta, MS Horticulture, Assistant Horticulturist

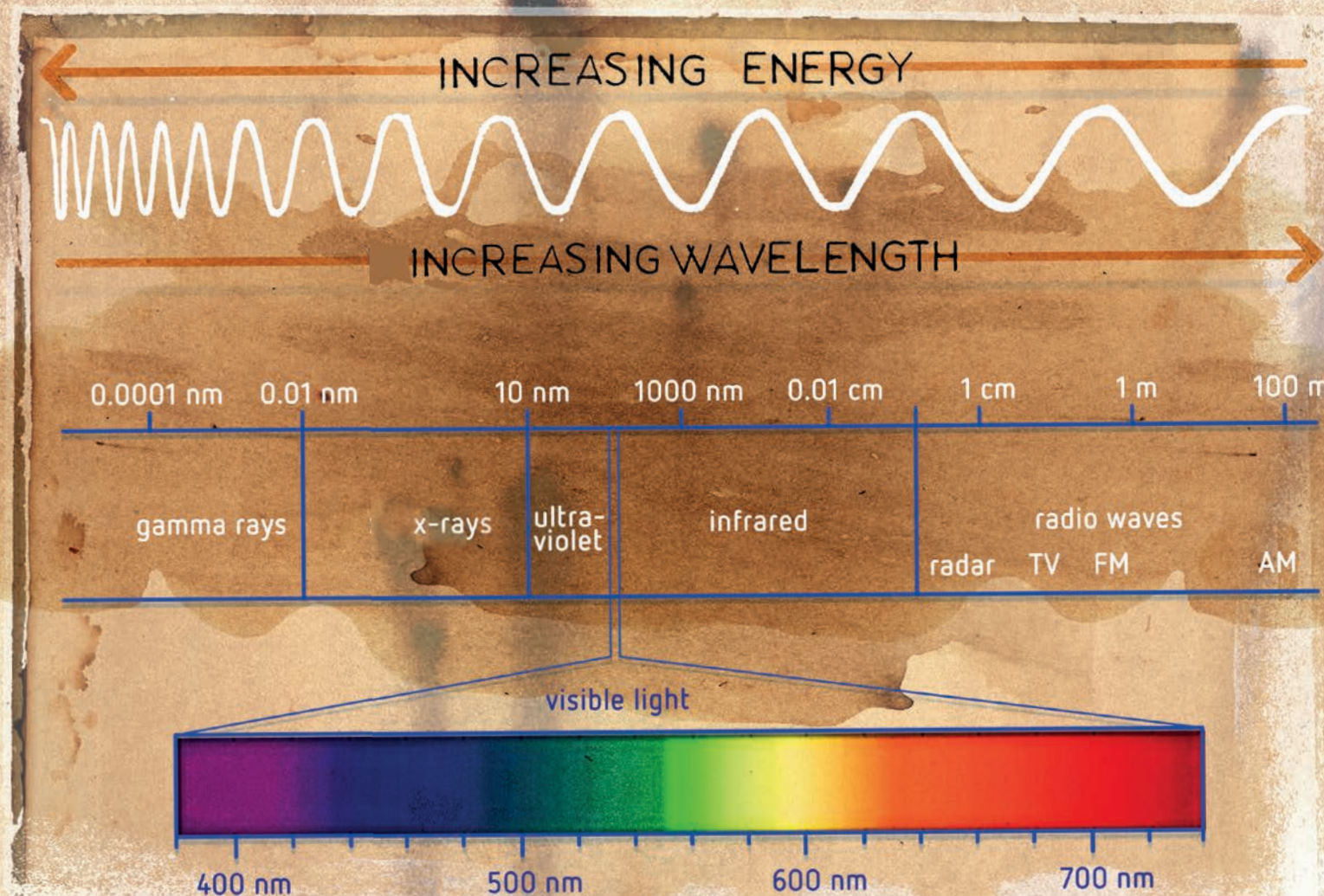
Light terminology

Visible light is defined as a type of electromagnetic radiation and has a wavelength in the 400-700 nanometers (nm) range, which represents the rainbow spectrum of colors. Plants absorb visible light, better known in the industry as photosynthetically active radiation (PAR). Plants also make use of some UV-light, which is less than 400 nm and just outside the visible spectrum.

Light travels in waveform and imparts energy on surfaces as if it were in particle form. Einstein, Planck, and other early 20th century quantum physicists established this behavior as the wave-particle duality theory, which has led many down rabbit-hole conversations on metaphysics and the plurality of life, but – back to visible light. Visible

light is absorbed as photons, which represent a quanta of light. The amount of photons hitting a surface area over time is known as light intensity and measured as photosynthetic photon flux density (PPFD). So, plants not only need the right light (PAR) to grow, they also need a minimum intensity of it. Plants each have a light saturation point, which

determines their threshold level above which greater intensity does not bring greater reward. A plant's light saturation point depends on its developmental stage, species, and management techniques. Generally, the appropriate intensity for seedlings or leafy plants like lettuce is 100-300 $\mu\text{mol}/\text{m}^2/\text{s}$, larger plants can use 400-600 $\mu\text{mol}/\text{m}^2/\text{s}$, and more mature, robust plants





LIGHT ABSORPTION

can handle 900 $\mu\text{mol}/\text{m}^2/\text{s}$. Vigorous growing plants have been shown to make use of 1500 $\mu\text{mol}/\text{m}^2/\text{s}$ and just as reference, sunlight at full exposure, mid-day can get as high as 2000 $\mu\text{mol}/\text{m}^2/\text{s}$.

Management technique can affect a plants light

saturation point. For example, when growers double the ambient levels of CO_2 (atmospheric is 400 ppm) to 800-1000 ppm, plants can effectively make use of greater light intensity, which increases photosynthesis (more growth!). To fully take advantage of CO_2 supplementation and the increased light saturation point, the air temperature needs to be higher (relative to the plant species' preferences). The CO_2 , light intensity, temperature trifecta works in concert to support a faster metabolism and improve plant gains.

The journey of when light meets plant

As light travels in wave-form and lands on a plants' surface, it is absorbed as a particle-like photon in pigments, located all over the plant. When a pigment absorbs a photon of light, it becomes excited, thus

initiating a plant response. Pigments are grouped in two ways.

Photoreceptor pigments – These include phytochromes, phototropins, and cryptochromes and can be found in most plant organs.

Photosynthetic pigments – These include chlorophylls and carotenoids and are found in chloroplasts – tiny organelles where photosynthesis occurs. Even more specifically, the pigments are located in the pancake shaped thylakoid membranes.

Each of these pigments absorbs a specific wavelength (or light color), called its absorption spectrum. When color or UV rays strike a plant's surface, a specific pigment is there to receive it and potentially trigger growth or morphology changes. Let's take a closer look at these reactions, showcasing each absorption spectrum one at a time.

Light color

Red (600-700 nm) and far red (700-750 nm) light

Suppose full spectrum ceramic metal halide lighting is shining down on your plants. The red light from the spectrum is absorbed very effectively by chlorophyll A and B, which are the primary pigments responsible for initiating the bulk of photosynthetic energy production. When chlorophyll A and B are excited by a photon, they convert that energy to adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADPH). ATP and NADPH are used as commerce coins in an array of metabolic processes including carbohydrate production, which serves as energy storage.

The red light that comes directly from your light source is also absorbed by a phytochrome pigment, known as Pr. Far red light comes from the reflection off of plants and is cast in the shadows. Far red is absorbed by Pr's sibling phytochrome, known as Pfr. When Pfr absorbs far red light, it converts to Pr and vice versa. The ratio of Pfr and Pr, known as the phytochrome photostationary state (PSS), helps a plant sense how much it is being shaded. As a result, plants in the shade will stretch their stems and increase the internode distance, so as to grow towards the light source. They may also be stimulated to create more chlorophyll to encourage more photosynthesis.

The parts of the plant most illuminated with red light are triggered to branch out and grow stockier internodal spacing, so as to maximize light absorption for photosynthesis. To bring that behavior back to phytochrome speak, this means the taller, well-lit plant parts absorb red light thereby converting Pr to Pfr, increasing the Pfr concentration to its threshold level, and just like that – the branching begins. The PSS of Pr to Pfr also helps a plant determine its photoperiod, which in turn affects flowering. When

plants are in the dark, after the lights have been turned off or the sun has set, the amount of far red light exceeds the amount of red light. During this dark period, the Pfr absorbs far red light and converts to Pr. The longer the night, the more conversions of Pfr to Pr and by morning plants find themselves with a low concentration of Pfr, which will trigger short-day plants to flower, like tobacco and cotton. Poppies and Echinacea are examples of long day plants. And there's nothing stopping day-neutral plants like cucumbers, peas, and roses, from flowering – regardless of the photoperiod. Lastly, when it comes to flowering, supplemental red light has the potential to affect secondary metabolite production and quantity of flowers.

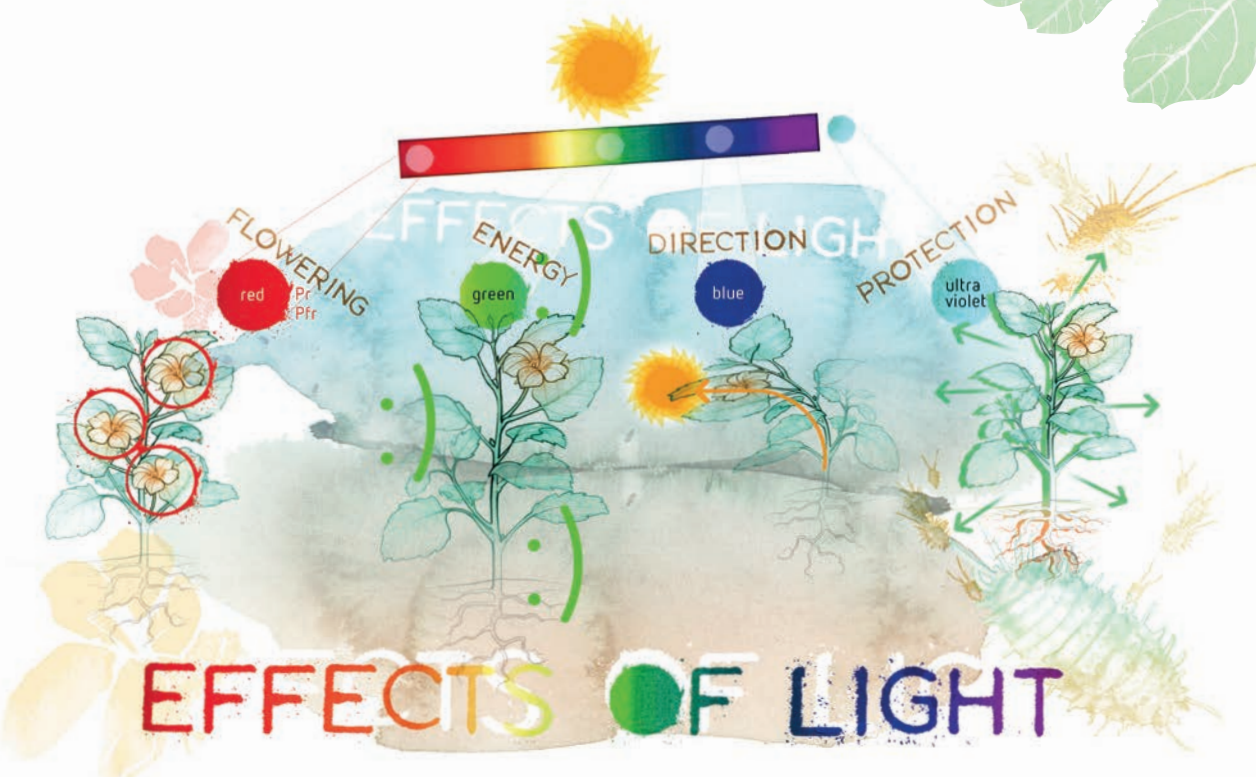
Green light (500-600 nm)

Although much green light is reflected off of plant surfaces, green light is still needed to maximize growth and if excluded, plant bleaching or undesired morphology may occur. Green light penetrates leaves more deeply, past the surface level chlorophylls and is absorbed by the deeper found carotenoids. There, carotenoids serve to transfer their excited energy over to the chlorophylls or to receive energy from the chlorophylls, which provides for overall greater energy absorption and subsequent photosynthesis. A low percentage of green light, less than 24% of the total supplied, can significantly increase biomass production. However, green light can also have an antagonistic effect on some of the blue-light induced improvements in flavor/quality profile. Such tradeoffs are important considerations for a grower when crafting their light spectrum specifically to their plants' needs.

Blue light (400-500 nm)

Blue light is absorbed by phototropins and cryptochromes. This triggers a reaction in the auxins located in plant cells farthest from the light source. This reaction causes the plant to elongate on that far side and as a result, the plant bends towards the light, in a phenomenon called phototropism. Cryptochromes also help the plant control germination and seedling development and they help with the switch from the vegetative to flowering stage.

Blue light regulates the stomata, the little openings on leaves that control both transpiration and CO_2 exchange and therefore are important for photosynthesis. A low level intensity of blue light is needed for basic photosynthesis, at 1-2 $\mu\text{mol}/\text{m}^2/\text{s}$. Generally, blue light influences plants to be shorter with smaller, thicker and darker green leaves, and can be used in practice as a growth regulator, often during the vegetative stage. In addition, just like with red light, blue light is highly absorptive by chlorophyll A and B, which is super impactful for energy production, photosynthesis, and



LIGHT ABSORPTION

sugar storage, as described above under, 'Red light.' Studies have shown that supplemental red and blue light can impact the secondary metabolite profile. Also, short wavelengths like blue and UV light can stimulate the antioxidant anthocyanin to be produced, which makes leaves turn purple.

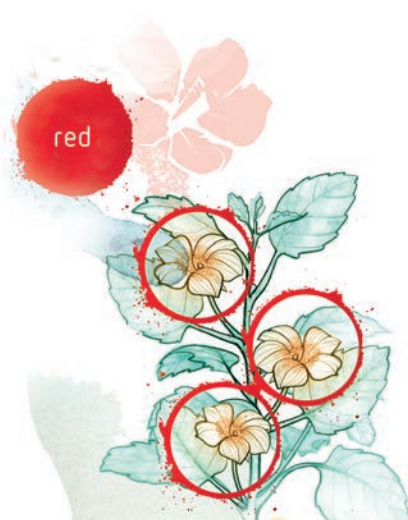
Ultraviolet light (100-400 nm)

Ultraviolet (UV) light resides outside of the PAR, however, it is still useful for plants and has impact. UV rays are absorbed by phototropins and cryptochromes, causing compact growth with short internodes, small, thick leaves, and more branching. Because UV and blue light both have short wavelengths, that means they release a high amount of energy. In response, plants can be triggered to produce more secondary metabolites (anthocyanins, flavonoids, carotenoids, potentially others) as a means of providing protection from the harmful rays. Similarly, these secondary metabolites can be helpful for pest resistance. Be careful with

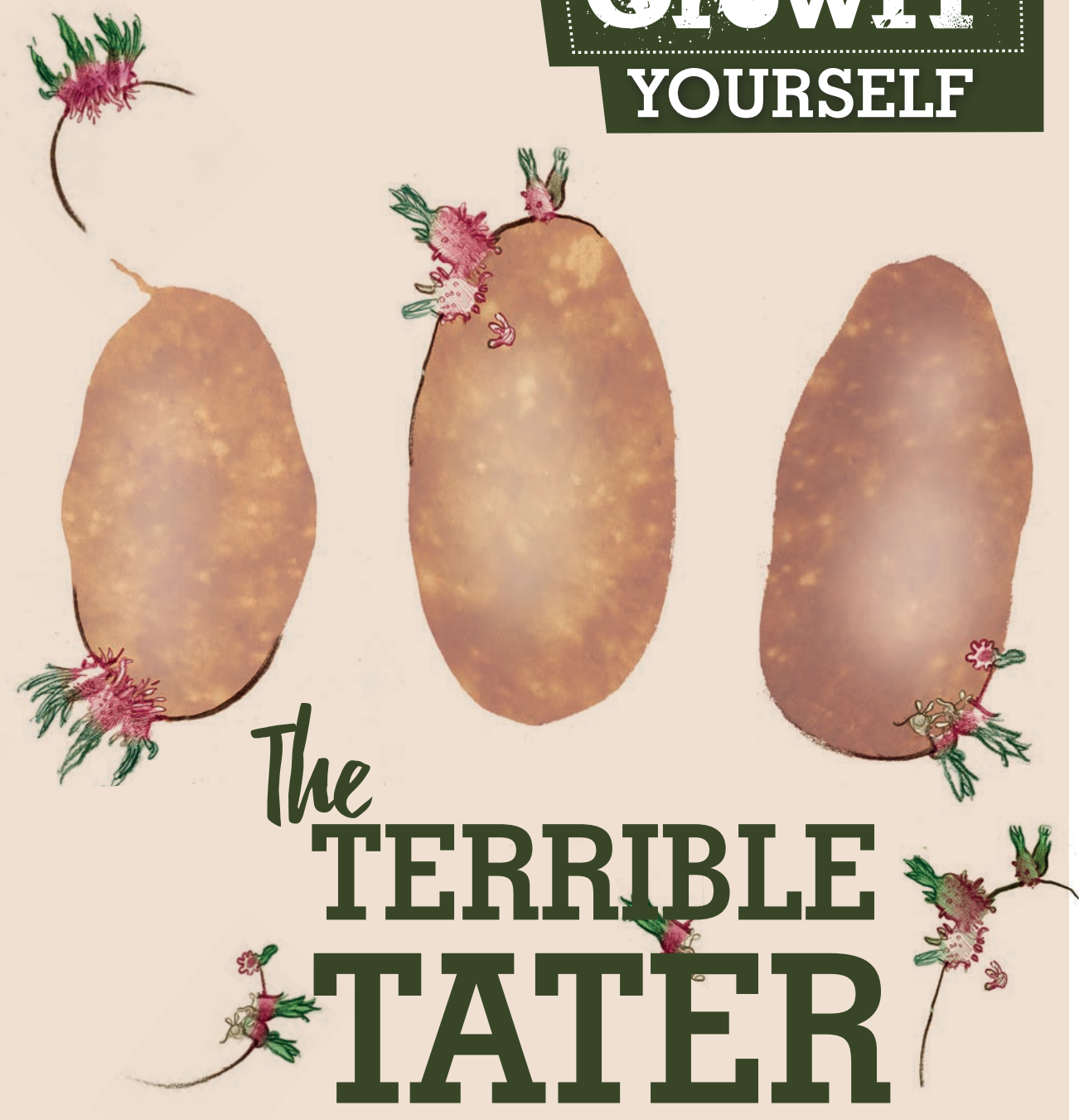
high energy UV light, since they can damage DNA and plant membranes. Avoid supplying more than 4 kJ/m²/day and as for humans, wear UV/blue-blocking safety glasses, avoid looking directly at the light, and wear long sleeves to protect your skin from the harmful rays.

Lighting the way forward

Generally speaking, plants benefit from the full rainbow of light colors, and certain colors are especially helpful with seedling development, vegetative growth, plant shape, flowering, and secondary metabolite production. It's important to remember that the combination of different light colors can lead to a higher photosynthesis rate than the sum of its parts. With the equipment available today, growers have even more flexibility to craft a personalized lighting regime and experiment as the industry continues to evolve in the way we light up. •



GrowIT YOURSELF



POOR POTATO. TOTALLY MISUNDERSTOOD, IT HAD TO FIGHT PREJUDICE EVERYWHERE. PEOPLE THOUGHT

THAT THE TUBER WAS WEIRD, POISONOUS AND DOWNRIGHT EVIL. THE TIMID TATER WAS ACCUSED OF

CAUSING LEPROSY, SYPHILIS, EARLY DEATH, STERILITY, SCROFULA, NARCOSIS AND EVEN RAMPANT

SEXUALITY. NOW WE KNOW BETTER. By Marco Barneveld, www.braindrain.nu

The story of our tater starts around 350 million years ago, when a poisonous ancestor of the nightshade family started to evolve into different plants: tobacco, chili peppers, egg plant, bell peppers and tomatoes for

instance. And... the potato! The potato slowly evolved into its current form in the South American Andean highlands between Peru and Bolivia, where about 3,000 different varieties of the potato can still be found. Human settlers



The TERRIBLE TATER

reached that part of our world around 15 thousand years ago, and managed to domesticate the wild ancestor of the potato around 8000 BC.

When Spanish conquistadors started exploring for gold in Peru, they found something better: our lovely and nutritious tater. They dug our little friend up and brought it along on their ships to Europe at the end of the 16th century.

Magical

European adoption of the potato was slow. The Spanish were the first to look beyond the dull appearance of the spud because when they fed it to their military and their navy, suddenly the soldiers did not croak of scurvy, which seemed like a miracle at the time. Now we know that the potato is packed with vitamin C, which prevents scurvy. But since vitamins were only discovered in the 20th century, it was like magic.

The rest of the continent only followed after a smart trick to fool the masses. The famous French botanist and chemist Antoine-Augustin Parmentier, who loved the potato, persuaded Louis XVI, the King of France (1754–1793) to encourage mass cultivation by tricking the population. The King gave Parmentier funds and land to grow 100 acres of potato, which were carefully guarded by military guards. Such large military and government attention on guarding these potatoes instantly sparked the attention of the people, who after that started adopting the potato more and more until it became one of the most popular food sources in Europe. The wife of the French king, Marie Antoinette (1755–1793), also contributed by pinning potato flowers in her curls, a move that was quickly emulated by noble ladies all across the Europe. It did not help her from losing her head during the French revolution, but our tater had nothing to do with that. Promise.

Potato famine

In the early 1800s, our potato could be found on almost any plate. Especially in Ireland where the nations' rainy, cool climate is perfect for producing spuds by the thousands. And since the tater is so nutritious, the Irish population nearly doubled in size between the late 1700s and mid-1800s. But even taters get sick. A *Phytophthora* water mold, called late blight infected and destroyed potato crops. Starting in 1845 and continuing into the early 1850s, potato plants rotted in the fields, and Irish citizens who had become dependent on the potato to sustain them and



supply most of their necessary nutrients were starving. During this Potato Famine around one million people died from starvation, and around half a million people were forced to emigrate out of Ireland to North America and Australia. But, our tater could not help that it got sick and all these terrible things happened. Promise.

From its early days in the Andes to its scarcity during the notorious Potato Famine and beyond, the spud made a comeback, and gone so far as to become a staple in pantries around the world. Affordable, filling, nutritious and... healthy.

Health benefits

If you're looking to power up your performance, look no further than the powerful potato. Did you know that potatoes provide the carbohydrates, potassium and energy you need to perform at your best? Potatoes are more energy-packed than any other popular vegetables. The tater is an excellent source of vitamin C. A portion of about a one cup of potato with the skin on has 27 mg of vitamin C per serving, which is 30% of the daily value. Potatoes are considered to be an excellent source of this antioxidant. Vitamin C aids in collagen production—a major component of muscle tissue— and supports iron absorption.

The spud contains more potassium than a banana. A cup of potato has 620 mg of potassium per serving, which is 15% of the daily value needed and more than a medium-sized banana. Potassium is an electrolyte essential for muscle functioning. Potassium is lost in sweat, so it needs to be replenished for optimal performance. Besides that, the potato will give you vitamin B6, fibre, and complex carbohydrates. And they are quite easy to grow.

Grow it yourself

Potatoes do best in full sun. The tater is an aggressively rooting plant, and will produce the best crop when planted in a light, loose, well-drained soil. It prefers a slightly acidic soil with a pH of 5.0 to 7.0. Fortunately, the potato is very adaptable and will almost always produce a respectable crop, even when the soil conditions and growing seasons are less than perfect. The potato should never be grown in the same spot until there has been a 3-4 year absence of potatoes.

The spud may be planted as soon as the ground can be worked in the early spring. The soil should be moist, but not water-logged. Potatoes can tolerate a light frost, but you should provide some frost protection for the plants if you know that a hard, late season freeze is coming.

Planting Potatoes

A good rule of thumb is to plant the potato whole if it smaller in size than a golf ball. It grows best in rows. Dig a

trench that is 6-8 inches deep. Plant a potato every 12-15 inches, with the rows spaced 3 feet apart. If your space is limited or if you would like to grow only baby potatoes, you can decrease the spacing between plants.

To begin with only fill the trench with 4 inches of soil. Let the plants start to grow and then continue to fill in the trench and even mound the soil around the plants as they continue to grow. Prior to planting, always make sure to cultivate the soil one last time. This will remove any weeds and will loosen the soil and allow the plants to become established more quickly.

Watering

Keep your potatoes well-watered throughout the summer, especially during the period when the plants are flowering and immediately following the flowering stage. During this flowering period the plants are creating their tubers and a steady water supply is crucial to good crop outcome. Potatoes do well with 1-2 inches of water or rain per week. When the foliage turns yellow and begins

to die back, discontinue watering. This will help start curing the potatoes for harvest time.

Harvesting

Baby potatoes typically can be harvested 2-3 weeks after the plants have finished flowering. Gently dig around the plants to remove potatoes for fresh eating, being careful not to be too intrusive. Try to remove the biggest new potatoes and leave the smaller ones in place so they can continue to grow. Only take what you need for immediate eating. Homegrown new potatoes are a luxury and should be used the same day that they are dug.

Potatoes that are going to be kept for storage should not be dug until 2-3 weeks after the foliage dies back. Carefully dig potatoes with a sturdy fork and if the weather is dry, allow the potatoes to lay in the field, unwashed, for 2-3 days. This curing step allows the skins to mature and is essential for good storage. You can store your potatoes well into the spring. Try to find a storage area that is well ventilated, dark, and cool. •

Eat it yourself:

The perfect budget-friendly, filling supper for one. The fragrant, zesty flavour of sumac is a refreshing contrast to the creamy whipped feta.

JACKET POTATO WITH WHIPPED FETA & SUMAC

Ingredients

- 1 baking potato
- 2 tsp olive oil
- ½ tsp garlic salt
- ¼ cup feta
- ¼ cup Greek yogurt
- 1 roasted red peppers, finely chopped
- ½ tsp sumac
- few basil leaves

Heat the oven to 425°F degrees. Prick the potato all over with a fork and bake for 1 hour until it is golden outside and soft inside. Mix half the olive oil with the garlic salt. Cut a deep cross into the top of the jacket, drizzle the garlic oil into the cross and rub it all over the outside. Return to the oven and bake for 15 mins more until the edges are golden and crispy.

Meanwhile, crumble the feta into a bowl, add the yogurt and whisk together until creamy. Stir in the red pepper with a good grind of black pepper and spoon the whipped feta into the jacket. Sprinkle with the sumac, drizzle over the remaining olive oil and scatter a few torn basil leaves on top. See, the tater is not that terrible at all.

Yummmm.



Questions & Answers

We receive a lot of questions about growing. Of course, our researchers are more than happy to answer them! Just go to the contact page on our website, www.cannagardening.com, to submit your question.

Question

I'm trying a new system with BioCANNA nutrients in soil, under LEDs. What should the pH be for the feeding solution and how long will it last in the reservoir?
I traditionally have plants in 1 gallon pots that are fed 4 to 6 times a day during flower. Is this a nutrient line that I can do the same with?

Answer

It's good to start by checking the pH of your plain water, so you get a sense of your water quality. For the BioCANNA solution, it's best to keep the pH between 5.0-7.0. The pH range is a bit broad and this is because it is designed for soil-based systems. A good soil or potting mix should come buffered with lime, which will also buffer your nutrient solution. With this built-in buffer, a soil-based system can handle a relatively broad pH range for the nutrients. Therefore, adjusting the pH is typically not needed. However, if you are keeping your solution in the tank for around 5 days, then be sure to check the pH to make sure it hasn't fluctuated out of range. Maintaining the proper pH helps protect nutrient quality in the reservoir. You can keep the nutrient solution in the tank for 3-5 days. After about 3 days it will begin to release sulfates, which emits a slight smell. This is not a problem, but best to use within 3-5 days to ensure freshness.

Start with fertilizing once a day and you can provide plain water in between feedings if needed. Limiting watering to once or twice a day can help prevent overwatering, but really your frequency of watering and fertility rate will depend on the developmental stage of the plant, temperature, and humidity. LED lights emit less heat than metal halide lamps, for example, so your plants may transpire less. With less transpiration, it may be helpful to increase the fertility rate to compensate for how the plant is moving through a smaller volume of water.



Question

I simply want to know if I should add CALMAG to reverse osmosis water till I bring the EC up to 0.4 mS/cm, before adding the CANNA Coco A&B. Is this correct or is there sufficient calcium and magnesium in the CANNA Coco A&B to satisfy the breakdown of the coir and the plant? I know CANNA sells a CALMAG product, so I was wondering if it was required.



Answer

Good question. Calcium and magnesium are important macronutrients to pay attention to in any system, especially a coco based system. Coco substrate has an affinity for calcium and magnesium, as does water, and the plants you're growing. For this reason, we buffered the coco substrate and designed Coco A&B with plenty of calcium and magnesium. This system was designed to work best with moderately hard water, meaning that your water contains about 60-120 ppm (0.12-0.24 mS/cm) of calcium carbonate equivalence (these are the ions that contribute to water hardness, and include both calcium and magnesium).

When you put water through a reverse osmosis filter, it becomes soft water, which is replete of calcium and magnesium. Over time soft water will pull away some of the calcium and magnesium from your nutrient solution, which may cause a deficiency down the line. To prevent this, you need to condition your RO or soft water with calmag. Use CANNA Calmag by first adding your nutrients and additives and then adding the Calmag at 2-4 ml/gal. Technically this should look like an addition of 0.12-0.24 mS/cm, so not as high as the 0.4 mS/cm you were thinking. Use a smaller dose when using a heavy nutrient rate (as shown on the feed chart) and use a larger dose when using a lower nutrient rate. Alternatively, if your original water is free from toxins, then you can mix that water with your RO water till you reach an EC of 0.2-0.4. You can do a slightly higher EC when mixing back tap water because the assumption is that it is a broader range of elements, not just calcium and magnesium, that contribute to the total solids from tap water.

I'm looking for some support with my setup. I am using CANNA Coco nutrients in drain to waste with coco medium. I recently added a 30-gallon reservoir tank. I had some issues with pH increasing and I started to use hydrogen peroxide to stop bacteria growth. I just realized that Boost says not to use with hydrogen peroxide. Will doing this hurt my plants or is there a better way to keep the reservoir tank clean?

It is natural for the pH to fluctuate in the tank and as long as it stays within the 5.5-6.2 range for Coco it is OK. The pH does tend to increase over time as it sits in the tank. As for bacteria growth, you need to fill your reservoir appropriately for your plant consumption, so that the solution is not sitting for more than 3-5 days, ideally. If you hold it for longer than that, there is greater chance for pH fluctuations and possibly other microbial growth. Generally, the microbial growth is not an issue however, that's not a guarantee since microbial growth is highly dependent on the environmental conditions.

Hydrogen peroxide is often used to sanitize reservoirs, equipment, and tools because it will break down anything organic - bacteria and microbes, substrate material, plant roots, and organic inputs like Boost, making those products a little less useful. It's best not to use it when and where plants are present. If you use it directly in your reservoir, consider potential damage to your roots and reduced efficacy of your organic inputs, and weigh out the tradeoffs for your particular situation. Hydrogen peroxide also can be used to treat fungal diseases in the root zone like Fusarium, Pythium, and Rhizoctonia, and mildews on leaf surfaces, however, it's generally avoided unless needed, since it also impacts healthy roots/leaves. It's best to start with disease prevention by keeping a clean, healthy, well-ventilated growing area.

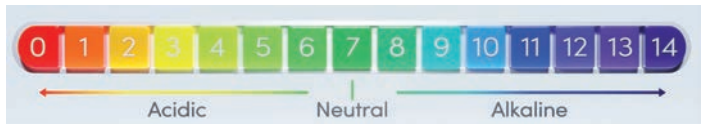
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Question

I'm trying to figure out what is needed and what is not in my recipe and to understand the science as opposed to just putting in a bunch of stuff thinking this is doing something and maybe it is not. I really like building microbial colonies in my grow, so using CANNA nutrients + microbes has been working for me. I've been using a couple compost teas for my vegetative period and another couple teas for my flowering period. I have also used some Bacillus, Trichoderma, mycorrhizae, and other beneficials. Are these microbes able to thrive in the coco environment?

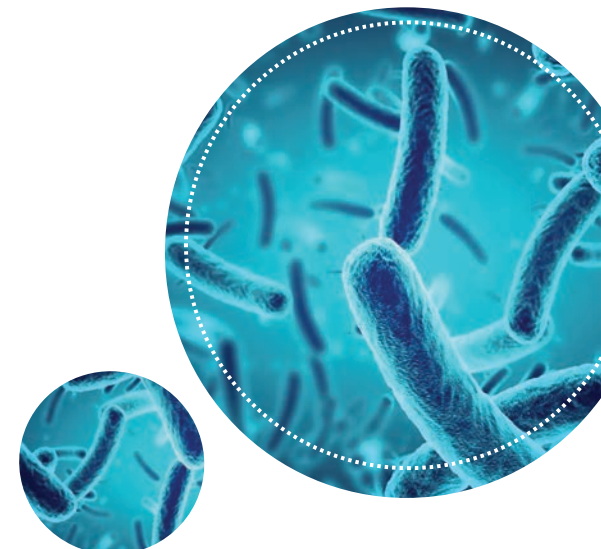
Answer

Microbes are definitely able to thrive in our coco system. The coconut substrate provides the ideal moisture content and air space needed to support microbes, so long as you are watering correctly. In addition to habitat, the microbes will need a food source like dead organic matter sloughed off from plant roots and your nutrient source.

While you don't need to add microbes to the coco system, if you want to use them think of the purpose that each of them will serve. You listed several - some are used for preventing soil fungal disease like Bacillus and Trichoderma, increasing nutrient uptake like mycorrhizae, and others are generally considered 'beneficials.' Coco A&B nutrients are already designed to be plant-available, so additional microbes like mycorrhizae are not needed to break down nutrients for the plant. Long term systems (greater than 3-6 mos) and especially soil-based systems, allow more time for microbial ecosystems to play a helpful hand with nutrient breakdown.

Since microbes will consume some of the nutrients you apply, beware that more is not necessarily more. Find the balance between what you are hoping to gain from the microbes and what it costs to support them. Another consideration for how to maintain a clean root system is to use Cannazym instead. Cannazym is made of enzymes and is OK to use throughout the grow period. It works to keep the root zone free of disease by breaking down old, discarded roots. If you are looking to

add supplemental microbes to your system, I would recommend using them just once or twice (at the beginning of veg and at the beginning of flowering) and don't add more than 1-2 products. Keep it simple.





Grower's circle

It is an exciting time to be an indoor or greenhouse grower. The future is upon us with major technological advancements in controlled agriculture emerging rapidly. One of the most significant developments has been in the field of lighting, with new LED designs pushing gardens to new and exciting heights. By George Hetfield

THE NEW FRONTIER: TRANSITIONING INTO THE WORLD OF LED LIGHTING

LED, or Light-Emitting Diodes, have been in production for horticultural applications since the early 2000s. From the start, they have been great additions to the garden. Unfortunately at that time, higher price tags of these first LED units combined with major advancements in HID lamp kits hindered their initial popularity. Now, the stars have aligned and LED has emerged as the new hot lighting tech on the scene.

For traditional HID growers, the attraction to LED can be strong but at the same time a little daunting. These new lights can look intimidatingly futuristic. From the light's cosmic purple-pink hue, to the space-age bar designs, it can seem like venturing into a whole new frontier of growing. Luckily, the transition into this brave new world is not as complex as it may seem.

First, let's point out the major differences between the two lights and why they are important to us as growers.

1. Power consumption- Assuming that you are running your power on 240 volts, most double ended HPS systems on the market today pull around 3.7 amps. A popular 600w LED system pulls 2.65 amps. A little over one amp may not seem like much, but can add up quickly over time (and scale for larger commercial growers). Although the up front cost of the LED system is typically more, this lower power draw can be very significant cumulatively, leading to considerable savings in electrical consumption.

2. Environmental impact- Aside from lowering the impact on our power grids, the lamp's life is also important to consider from a waste perspective. DE HID bulbs have an average of 10,000-25,000 hours of use before needing to be changed, although models and application will vary life expectancy. In comparison, LED diodes run for 50,000-60,000 hours before needing to be serviced/replaced. Check with the manufacturer of the model you chose for more details on long term maintenance. Also, always dispose of bulbs

responsibly to keep hazardous metals out of our landfills.

3. Heat/Garden Design- Anyone who has worked with DE HID bulbs knows that they produce a noticeable amount of heat. Just holding your hand up to the fixture (but not touching it) is enough to feel that plants will need some environmental control to help offset the increased intensity to the garden. LED, on the other hand, while still producing some heat, is noticeably cooler. This is important to us growers in two ways- HVAC/air circulation design and plant layout. We still need to be very mindful of moving air properly to avoid heat channels, or hot-spots, in the garden. More on this later, since this is probably the most practical and important for us indoor gardeners.

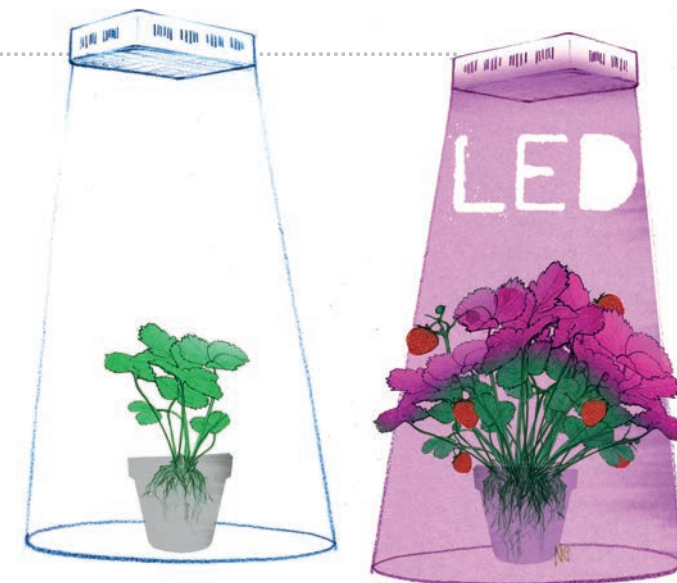
4. Spectrum- The graphics on the next page perfectly illustrate how much more diverse a spectrum that LED provides compared to traditional DE HID lamps. This subject requires some deeper discussion, so let's dive into some specifics to better understand this important lighting element.

Simply put, the spectrum, or wavelength of the light, is what the plant "sees" and is measured in PAR or "photosynthetic active radiation" (refer to the article "Light

Absorption and Color Dependent Plant Interactions in this issue for more details on this subject). Research has shown that the spectrum output by grow lamps target specific photo-receptors that trigger different types of growth or development. To state the obvious- the type of light given to the plant affects how it grows. We see this with our traditional HID lamps. Any seasoned indoor gardener can attest that "warmer" HPS (high-pressure sodium) light has a noticeably different effect on internodal spacing and leaf set formation than the preferred cooler light given off by MH (metal halide) lamps.

This ability to deliver both a broad, but very specific, spectrum is one of the major reason that LED separates itself from traditional HID lamps. Just like our MH bulb example above, the new LED spectrum has been seen to elicit different plant responses than those observed with HID lamps. While HID traditionally produces the best light intensity for flower production from mostly reddish and yellow light, the amounts and variety of the wavelengths produced by LED are what can translate to fantastic productivity with much lower power and heat in the garden. It is important to note that most noticeably lacking from some LED models is the UV or ultraviolet wavelength. This blue or purple wavelength of the spectrum is equally important as these reds and yellows for flowering, as well as stomatal control, and should be supplemented with something like a CMH (ceramic metal halide) or UV LED bar if not present. Now that we have covered the basics let's get ready to hang some lights!

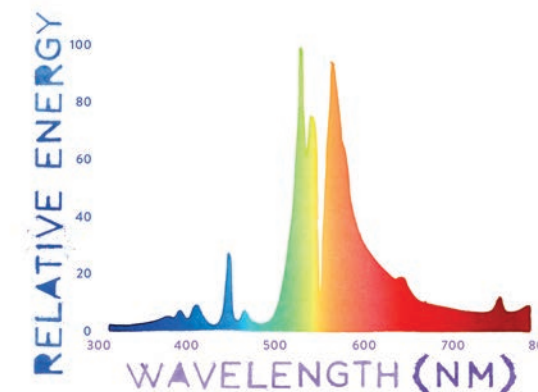
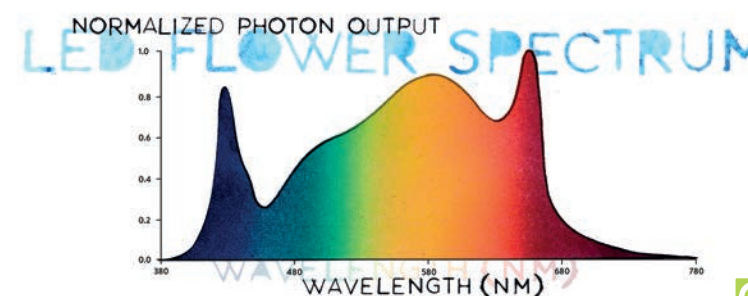
To begin to set our new LED garden, we need to start from the foundation- propagation. Traditional gardens typically use florescent lighting due to low heat and the ability to keep lighting close to our young plants to decrease stretching and induce rooting development in cuttings. This can be true for LED as well, but anyone who has experimented with LED lighting can testify that these lights ability to target the desired wavelength (color) has dramatic results in rooting cuttings. The purple/magenta wavelength is ideal for propagation and some growers have seen faster root development in a shorter period of time. So vigorous is this rooting, that many propagation gurus report new cuttings' potential to develop a slight phosphorus deficiency once transplanted since feeding is typically not ramped up to high levels at this stage of growth.



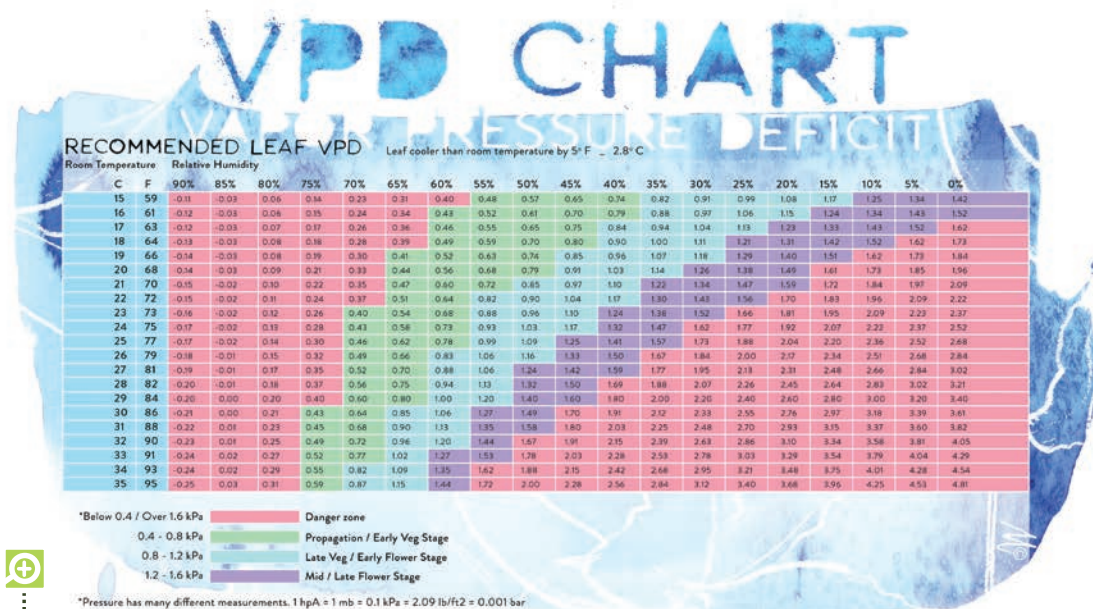
This intense growth can be observed even more as your garden matures during the vegetative phase. Most gardeners report noticeably bushier plants, with much broader leaf sets and thicker stems and stalks. This is a prime example of how specific wavelengths can trigger these responses being delivered in a much higher intensity than our traditional veg lighting.

Like we touched on above with our discussion of spectrum, flowering plants can also have an equally dramatic reaction to this new type of extra broad, but specific, light. To better understand these changes from HID we need to take a look at the key elements to success with any lamp-environmental control and irrigation.

We have already mentioned that these LED lights can be placed closer to the plant due to the diodes' lower heat output. The difference can be felt by placing the back of your hand close to the light source. What you are feeling is the far red, or infrared light, given off by the lamp. Knowing the true temperature at the surface of the canopy is a key element to properly dialing in our garden design. A great way to accurately record this difference is to use an infrared thermometer that can be found in kitchen or hardware stores. Traditionally, we have seen that most open hood double-ended HID lamps need at least two feet from the canopy to avoid damage from the infrared heat we are concerned about. LED lights do not have this issue, so their



LED spectrum (on left) optimized for flowering compared to High Pressure Sodium DE bulb (on right). Take notice of increased intensity and diversity of the LED spectrum.



VPD chart illustrates the ideal temperature and humidity parameters for optimal conditions in a garden. The orange band highlights the correct levels during flowering

ability to be closer to the plants (almost touching) allows for more flexibility in garden design. Utilizing vertical space with tiered racking systems has become increasingly popular in commercial production but the ability to keep the fixture closer to the canopy is also great for growers working in spaces with lower ceiling heights. Although ceramic metal halides are an example of an HID fixture that can be placed close (about a foot), these LED fixtures can be placed even closer. The result is an increased light intensity, measured as PPFD (photosynthetic photon light density), reaching the plant and getting deeper penetration into the canopy. This has the potential to translate into more vigorous growth without the risk of damage from infrared heat.

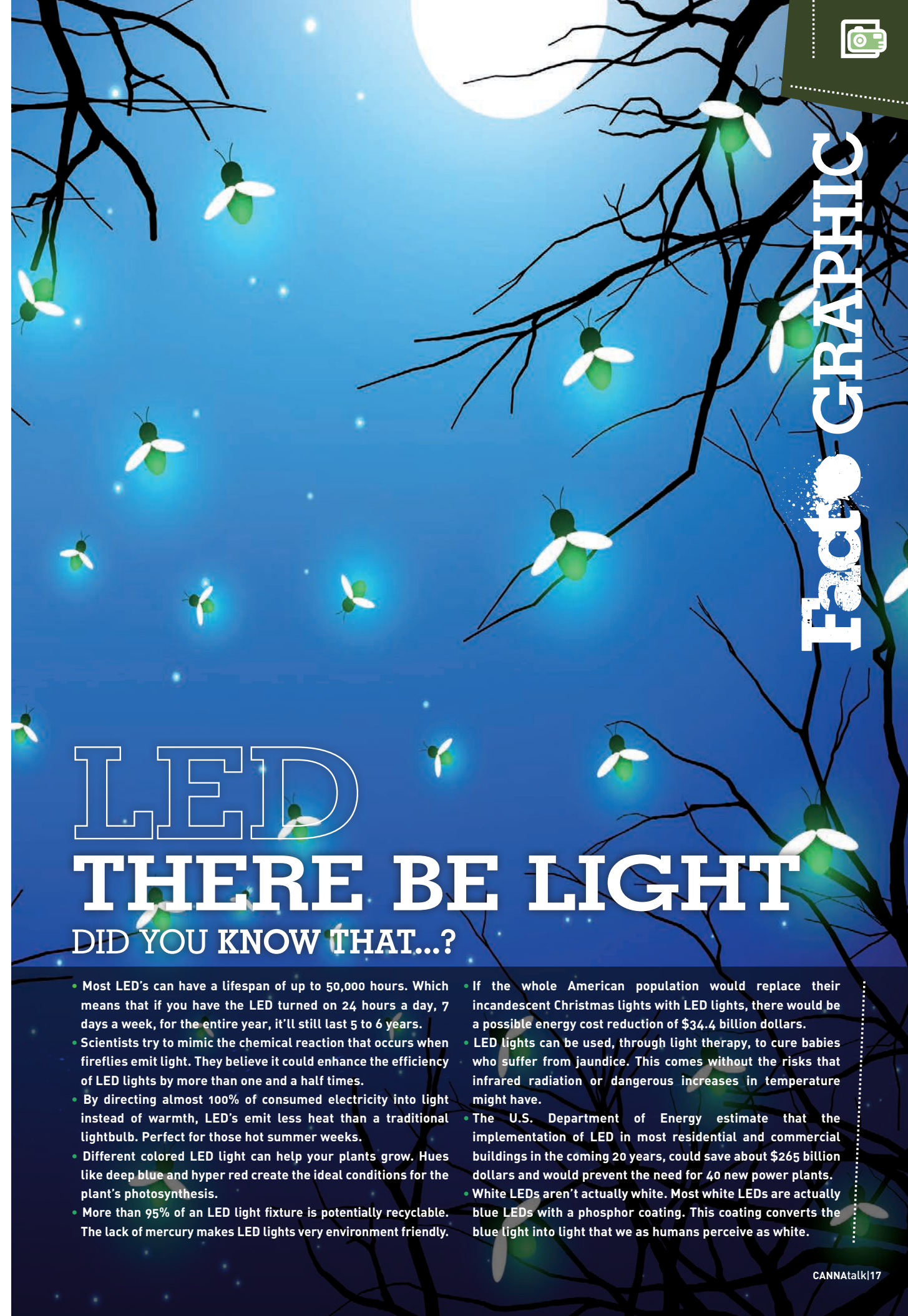
Now let's talk more about probably the most important factor to success in the garden- watering- or more specifically how temperature and humidity in the room effect how we fertilize and water. In traditional HID lamp systems, it is typical that a more intense environment from increased PPFD, (more lamps and heat) results in the plants need for more frequent irrigation. Plant and container size are major factors that influence this, but most growers decrease the EC/PPM of their nutrient solution to prevent fertilizer accumulation in the media from this intense environment that the HID lamps have created. Think of it as a runner in the hot sun- the guy sweating heavily and working hard doesn't want a cheeseburger but rather an electrolyte packed gummy to keep his energy up without slowing him down.

LED environments do need some special considerations. Like testing your leaf surface temps will show you, LED lamps do not produce the infrared heat that HID bulbs do, so attention must be paid to keep your garden parameters in line with your plant needs. You want your leaf temps that you succeed at in your HID garden to be the same when you switch over to LED. This means keeping your garden ambient air temps slightly higher (low-mid 80's)

by raising the environmental settings on your controllers. When things get hotter in our gardens, what happens to our plants? An increase in transpiration (sweating) should be compensated by paying closer attention to our humidity to maintain proper VPD levels. This could mean more dehumidification in some cases but as the chart below shows humidity and temps need to be adjusted together in unison to maintain balance in the garden.

With our lights hung correctly and our garden environment dialed in, let's discuss how to properly feed our plants in this new setup. As we have mentioned several times, the new LED light changes how the plant grows. This should come as no surprise that this effects the plants metabolism or how it wants to feed. Because the spectrum reaching the plants is so diverse and the light is so intense, LED lighting has the potential to trigger a plants internal cycles to fire at higher rates. This can be observed in the garden as an increase in the plants demand for food. EC/PPM concentrations need to be increased in the proper ratios to keep the plant at optimal health and free of deficiencies. Unlike the runner in our HID example, plants grown under LED lights seem to be more akin to a sumo wrestler. This type of athlete works just as hard as the runner but needs a significantly higher caloric intake to maintain the physique he needs to compete in his arena. Regardless of the lights you chose, growers need to be sure they are tailoring their watering and feeding to the conditions in the garden while meeting the needs of the plants being grown.

Like with any journey into the unknown, there is always some amount of trepidation or caution. Our hope, fellow growers, is that your voyage into this new world of LED gardening can now be met with excitement and confidence! Armed with the tools to implement this next generation of technology in your garden it's time to fire up some lights and blast off into a new world of growing! •



Factor • GRAPHIC

LED THERE BE LIGHT

DID YOU KNOW THAT...?

- Most LED's can have a lifespan of up to 50,000 hours. Which means that if you have the LED turned on 24 hours a day, 7 days a week, for the entire year, it'll still last 5 to 6 years.
- Scientists try to mimic the chemical reaction that occurs when fireflies emit light. They believe it could enhance the efficiency of LED lights by more than one and a half times.
- By directing almost 100% of consumed electricity into light instead of warmth, LED's emit less heat than a traditional lightbulb. Perfect for those hot summer weeks.
- Different colored LED light can help your plants grow. Hues like deep blue and hyper red create the ideal conditions for the plant's photosynthesis.
- More than 95% of an LED light fixture is potentially recyclable. The lack of mercury makes LED lights very environment friendly.
- If the whole American population would replace their incandescent Christmas lights with LED lights, there would be a possible energy cost reduction of \$34.4 billion dollars.
- LED lights can be used, through light therapy, to cure babies who suffer from jaundice. This comes without the risks that infrared radiation or dangerous increases in temperature might have.
- The U.S. Department of Energy estimate that the implementation of LED in most residential and commercial buildings in the coming 20 years, could save about \$265 billion dollars and would prevent the need for 40 new power plants.
- White LEDs aren't actually white. Most white LEDs are actually blue LEDs with a phosphor coating. This coating converts the blue light into light that we as humans perceive as white.



What's HAPPENING

How are we going to feed 9.7 billion people in 2050? Easy. Imagine a world with skyscraper greenhouses with aeroponic technology that provides the perfect conditions for healthy plants to thrive, taking indoor vertical farming to a new level of precision and productivity. That future is here.

By Marco Barneveld, www.braindrain.nu

THE SKY'S THE LIMIT



The Netherlands is the world's second-largest exporter of agricultural products right after the USA and before Germany. Ponder on that for a second. The Netherlands is one of the smallest countries on the planet and is also incredibly densely populated. The USA is almost twenty-four times bigger, Germany nine times bigger. How are the Dutch so productive? One of the reasons is their highly efficient greenhouses. Now ponder on this. Holland is still growing in normal, ground level, greenhouses. What if we were to take that to the next level? Literally.

There is a lot of experimenting going on in farming. Understandably so. Fewer farmers are increasingly under pressure to feed more people. The UN predicts that the world population will rise from 7.3 billion today to 9.7 billion in 2050. Plus, there is an overall push to make farming greener by using less water and pesticides. Enter precision agriculture. Enter high-tech. Fully-controlled indoor vertical farming yields 119 times greater productivity per square meter annually vs traditional field farming while potentially using 95% less water and less pesticides.

AeroFarms specializes in vertical farming. The company is on a mission since 2004 to transform agriculture. "Cities have a lot of mouths to feed. We have population

growth, urbanization, and we need better ways to feed humanity that are sensitive to the environment," Aerofarms' CEO and founder David Rosenberg says. "Vertical farms are one of the solutions."

A look at vertical farming

Picture a vegetable farm, and you might imagine growers digging through dirt and planting rows of seeds. Besides the occasional spray of pesticide and pH check, all the plants need are sunlight, fertilizer, and water.

Vertical farms, like the ones Aerofarms creates, are nothing like that. Instead of soil, plants are placed in trays stacked 10 meters high. Fans spin continuously, and aeroponics is used to mist the roots of the greens with nutrients, water, and oxygen every few hours. Macro- and micronutrients for the plants are constantly monitored to provide them with everything that they need to thrive.

The greens don't thrive on sunlight; they are basking in LED lights instead. These special lights are designed to create a specific light recipe for each plant, giving the greens the exact the spectrum, intensity, and frequency they need for photosynthesis in the most energy-efficient

way possible. This engineered lighting allows us to control size, shape, texture, colour, flavour, and nutrition with razor-sharp precision and increased productivity. Pests can, well, be pests. But, since every aspect of the growing process is being optimized to minimize and mitigate pest proliferation, these new growing methods disrupt the normal life cycle of common indoor pests so that they never get started. This way, the same seed from the field grows in half the time than through traditional farming.

Precision-based growing

Besides all that data is collected to monitor and learn about the plants. Aerofarms' growing trays collect 30,000 data points on things like temperature, humidity, CO2 and oxygen levels. Data scientists from universities, including Harvard and MIT, analyse these metrics in real-time using machine-learning software.

The goal is to optimize the growing algorithms of 250 different types of plants, including kale, arugula, and mizuna plants. Once the farmers figure out the best way to grow the greens, they can replicate the method every time. Aerofarms then plans to send out the greens to places in the local metro area that don't normally have access to fresh produce.

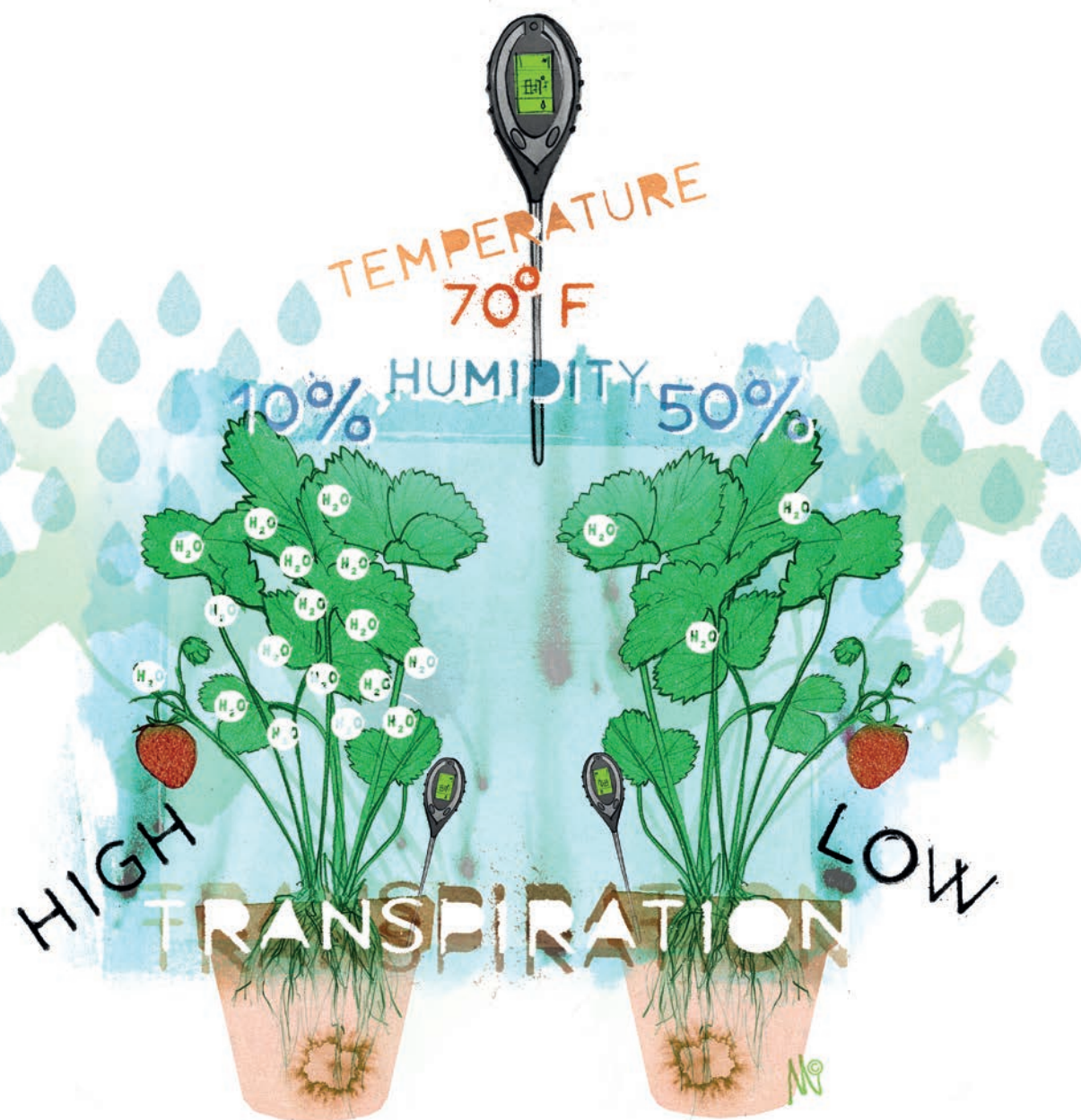
The world is picking up in the future. Abu Dhabi, the capital of the United Arab Emirates, is investing 100 million in a giant vertical farm which will produce 10,000 tons of food in the middle of the desert. Imagine the potential of growing massive amounts of food in a place where the sun normally scorches anything that wants to grow. And, imagine now, that it will be exactly that same sun that'll be helping to energize all the air conditioning and lights.

Now imagine again, what if we'd use robots to do all the small tasks? Which country was trailblazing this exciting future of gardening? Japan, of course. The Japanese agricultural company Spread has been, with the vertical farming technique of Aerofarms, successfully running the first robot-run vertical lettuce farm, which pumps out three thousand kilos of lettuce (about 30,000 lettuces) per day.

We are on the brink of an agricultural revolution. A future that could have one skyscraper of vertical farms on the edge of every metropolis. Feeding its inhabitants fresh produce every day without having to transport it all over the world. That should be good for the planet, and its people. The future is now. •

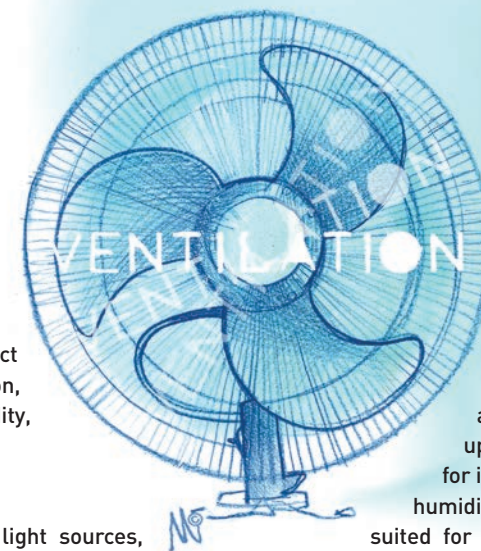


Pests & DISEASES



AIR QUALITY AS A SOURCE OF DISEASE

One of the biggest ways you can help keep your plants free from pests and diseases is to design your garden to provide good air quality through proper ventilation and temperature setting. While fluctuations may happen that we can't always control, it's best to be prepared for how these changes may impact your plants and potentially create the perfect habitat for pests and diseases. By Abha Gupta, MS Horticulture



Here's a closer look at the impact of air quality on plant production, focusing on temperature, humidity, and gaseous composition.

Temperature

Plants are subject to heat from light sources, regional climate, and weather fluctuations. The ideal temperature for most plants is 72-76°F during the day and the night temperature can drop by 5-10°F. When the temperature drops more than 15 degrees, condensation is likely to occur which may cause humidity and subsequent mold issues like Botrytis (gray mold) and powdery mildew. As with most plants, daytime temperatures above 85°F and below 55°F slows or stops the growth of plants. Also, when temperatures rise above 85°F plants are at higher risk of burning and having a reduction in flowering.

Humidity

Humidity, or water vapor, directly relates to temperature. Warmer air allows for more vapor whereas cooler air allows for less vapor. This explains why snowy, brisk landscapes often have very low humidity. Another way to describe humidity is by vapor pressure deficit (VPD), which is the difference between the saturation point and the air vapor. The ideal humidity level for seedlings and cuttings is 80-95%, vegetative plants is 60-70%, and flowering plants is 40-60%.

When humidity is high, the plant transpires less and therefore takes up less water. If you fertilize primarily from feeding nutrients along with your water (known as fertigation) and the plant takes up less water, then it's possible for the plant to become nutrient deficient. To account for lower water uptake, you may want to increase your fertilizer rate. On the other end, low humidity causes faster transpiration and more water uptake, so you may want to lower your fertilizer rate under those conditions. Consider humidity as it affects nutrient uptake, especially when it comes to liquid-fed systems.

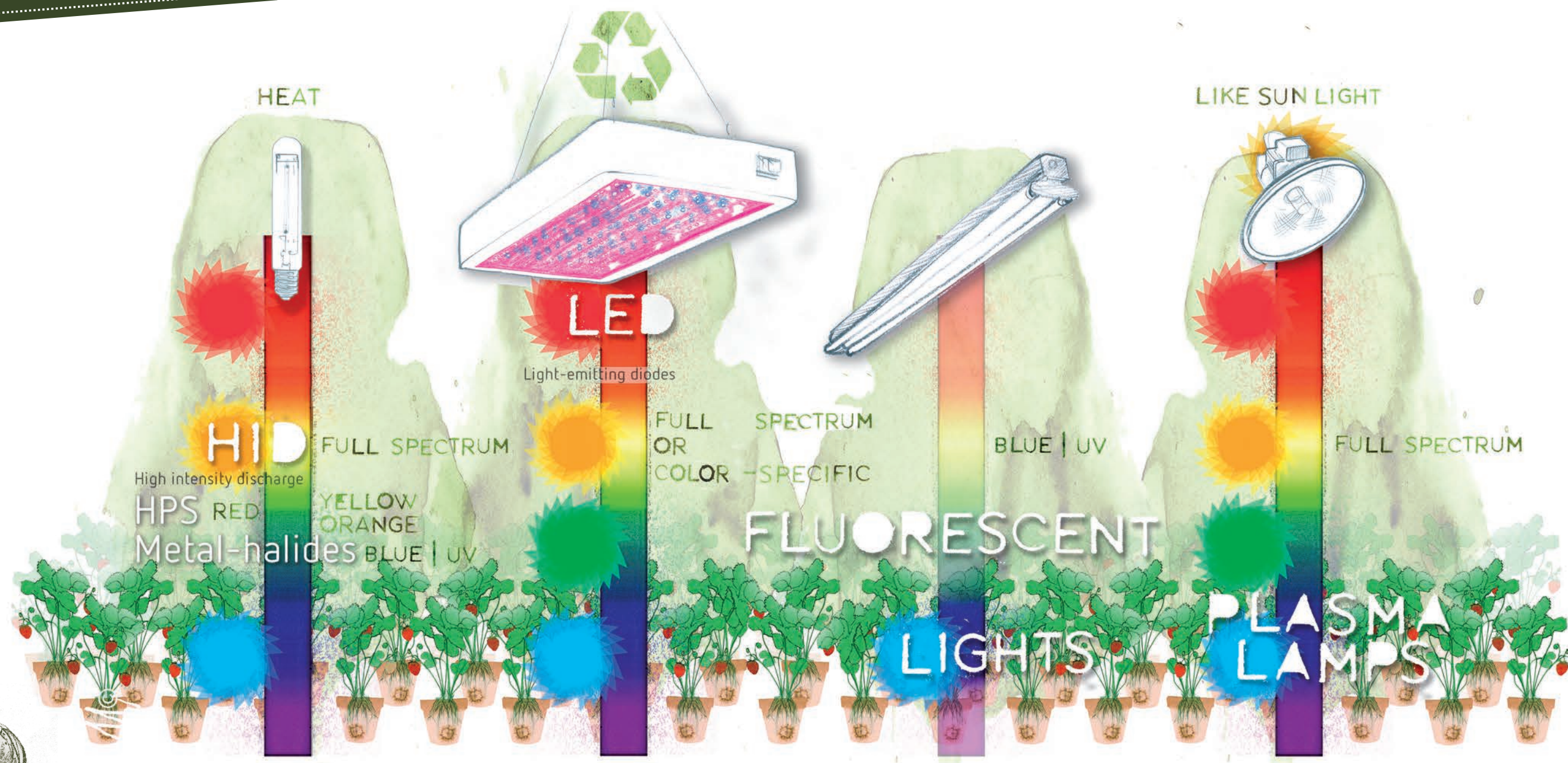
In terms of disease, higher humidity supports foliar molds like Botrytis and powdery mildew and soil borne fungal diseases as well, like Rhizoctonia, Fusarium, and Pythium.

Too low humidity can cause foliar damage as well, as the leaves thin and may burn while trying to keep up with a higher transpiration rate. As for insect pests, spider mites prefer low humidity conditions while aphids are more suited for high humidity. Flower shape may also be affected by humidity. In high humidity conditions, flowers may space out more, appearing fluffy in order to try to accommodate more air flow, whereas compact flowers may result from dryer locations.

Ventilation and CO₂

When growing indoors, proper ventilation is needed to make sure that plants are getting enough fresh air, with sufficient carbon dioxide (CO₂) for plants to use during photosynthesis. While many grow spaces allow sufficient air flow through doors and natural venting, in tightly sealed greenhouses the concentration of CO₂ can become very low during the day and much higher at night. Carbon dioxide levels can get as low as 150-200 ppm during the day, while in comparison the atmosphere contains 400 ppm. When plants are exposed to lower levels of CO₂, even for short periods, the rate of photosynthesis and growth can slow. Using fans is an easy way to provide fresh air to your plants and also help maintain the appropriate humidity and temperature. Be sure to choose the right fan for the size of your space, measured in cubic feet (length x width x height). Look for the cubic feet per minute (CFM) rating on fans, which describes how much air the fan can move in a minute. For an added boost, some growers choose to supplement their grow spaces with CO₂, elevating the concentration to 800-1000 ppm, which has the potential to increase plant production. Carbon dioxide levels over 2000 ppm may cause damage to plants and is dangerous to humans and animals.

In order to best protect your plants, it's ideal to start from the beginning and design your garden to provide good air quality. If conditions change and become less than ideal, consider how your plants may be impacted and be prepared to treat potential issues. The more you know in advance on how changes to your system may affect your plants, the better off you will be as a grower. •



RADIANT OPTIONS

THE LIGHTING EQUIPMENT AVAILABLE IN THE MARKET TODAY EACH HAS ITS SPECIFIC DESIGN, CONSIDERATIONS, AND APPLICATIONS. IN THIS ARTICLE, WE'LL BREAK DOWN HOW THESE LIGHTS WORK AND THEIR DISTINCT QUALITIES THAT YOU'LL WANT TO CONSIDER WHEN CREATING YOUR LIGHTING SYSTEM.

By Abha Gupta, MS Horticulture, Assistant Horticulturist

Back in simpler times, the sun was the only light source humans used to power plant production. Sunlight emits UV rays and full spectrum light, meaning all of the colors of the rainbow shine out from sunbeams. Both light color and UV rays affect plant development and fruit quality (refer to the previous article on light absorption and color dependent interactions to learn more).

In our modern life we having lighting options, so we can stretch our seasons and grow places where ordinarily impossible. Lights are being used as the primary lighting source for plant production or as supplemental lighting, serving as a component of a lighting system. The most common lighting equipment on the market today include the family of high intensity discharge (HID) lamps, light



RADIANT OPTIONS

emitting diodes (LEDs), fluorescent lights, and plasma lamps. Let's take a look at each of these equipment options and their respective mechanics, light spectrum, intensity, and practical applications.

High intensity discharge (HID) lamps

The most common type of lighting in horticulture today is high-intensity discharge (HID) lamps. Bulbs fitted for HID lamps can come in a typical bulb shape, dropping down, or double ended (DE). DE HID lights are like a tube that plugs into two ends of a ballast and allow more light to reach the canopy. HID bulbs are fragile and contain metals, so handle them with care and be sure to properly dispose of them at your local hazardous materials disposal site. The combination of metals sealed in the arc tube determines the color spectrum produced. HID lamps produce light by passing electricity through the gaseous metals at high pressure, which heats and then emits light. Given that the gas-metal mixture needs to heat up, these lights require some warm up time before they fully illuminate. The amount of power delivered to the light is regulated by a ballast.

The HID family of lights include metal halide (MH) and high pressure sodium (HPS). HPS lights emit a yellow light, favor the red to yellow/orange spectrum, and contain little blue. This color spectrum is due to the narrower bands of chemicals used to dose the arc tube of the bulb. The color from HPS is well suited for flowering stages. In addition, the arc tube is contained within a larger glass bulb, which filters out most of the UV rays. HPS lights are sometimes used in combination with plasma lamps to give a more uniform spectrum and also provide UV rays.

Metal halides (MH) emit a white light and favor the blue spectrum, making them more favorable for vegetative growth. Ceramic metal halides (CMH) or light emitting ceramic (LEC) lights, produce broad spectrum lighting as well as UV light. Metal halides are sometimes described by their color temperature, measured in Kelvin (K) degrees. Temperatures from 2700-3000K are called warm colors and emit a yellowish light while temperatures over 5000K are considered cool colors and emit a bluish light. In this sense, "warm" lighting actually has a lower temperature than "cooler" light, which has led to some confusion, so be aware.

HIDs generally release a lot of infrared light, felt as heat. To prevent light burn, be sure to adjust the distance between the lights and your plants, depending on plant growth stage and size/wattage of your lamp.

The "hand test" is a good way to check if your distance is ok for your plants. Place your hand close to your plants for 30 seconds and if it feels uncomfortably warm for your hand, then it is likely too hot for your plants and you should move your light farther away. A more precise way to verify if you have the correct distance is by using a simple light intensity meter – a worthy investment for better assessing your grow set-up.

Light-emitting diodes (LEDs)

LEDs have evolved over the last decade, improving in efficiency, lifespan, and color spectrum. Also, they continue to gain attention as demand increases for more environmentally-friendly production methods. LEDs are semi-conductors that produce light by a process called electro-luminescence. When an electric current flows through an LED, the electrons in the semiconductor recombine with electron holes, and in the process release energy in the form of photons. The color emitted by the photons depends on the semi-conductive material in the LED. Rather than a ballast, a series of resistors are used to deliver the right voltage and current. The power supply can be decreased to dim lights, which give growers the option of varying the level of intensity that LEDs provide.

LEDs are available as full spectrum or as a selection of colors, called narrow spectrum, often being red and blue. With multiple light color options available, LEDs can be used from seed to flowering or to target specific production goals. The appropriate distance from LEDs, whether they are used for seedling development or up to flowering, depends on the wattage of the LED being used.

Fluorescent lights

Fluorescent lights work by using an electric current to excite mercury vapor, which produces short-wave UV light to then cause a phosphor coating inside the light to glow. Fluorescent tubular bulbs come in a wide variety of lengths from 6 inches to 8 feet and are used widely as interior lighting. The bulbs come in at least 7 different diameters, noted as T4, 5, 8, 9, 12, 17 and so on. A T5 bulb has a diameter of 5/8 of an inch and a T12 bulb has a diameter of 12/8 of an inch, or 1.5 inches. The narrower the bulb, the more efficient and brighter, which is why growers typically use a T5 bulb, with an additional high output (HO) rating. Larger fluorescent bulbs are better suited for interior lighting.

Fluorescent lights emit a more blue toned light and are generally used for seedlings and cuttings, with most growers turning to T5 HO lights. Light emission is strongest near the center of the tube and somewhat less



High intensity discharge bulb



Light emitting diode



Fluorescent lights



RADIANT OPTIONS



Plasma lamp



at the ends. Growers have also had success using these lights for fully grown vegetative crops, like lettuce, however these lights are still primarily used for early growth. Growers can use T12 bulbs for very small seedlings, though they generally are not recommended since they lack the ideal intensity. Compact fluorescent lights (CFLs) with their characteristic helical spiral have been used for very small grow spaces, however, be aware of the need to still get sufficient light intensity. Fluorescent lights can be kept close to plants, less than 6 inches, since they typically do not produce enough light to cause burning.

Plasma lamps

Plasma lamps generate light by using radio frequency to excite plasma inside a closed bulb. These lamps use noble gases and additional materials such as metal halides, sodium, mercury, or sulfur. A radio frequency generator, called a magnetron is used and, although it may look like it, is not actually a ballast. The light has a spectrum and color temperature similar to that of the sun (around 5900K) which is why the light from plasma lamps is also called artificial sunlight. The light spectrum contains more blue light and also emits UV-B, while UV-C, which is more harmful to plants and people, is filtered out. The safe distance to keep between the light and your plants will vary based on the plants' developmental stage.

Plasma lamps tend to use less energy than HID lights and in theory can provide appropriate light till harvest, however, they are generally cost prohibitive for growers to completely rely on. Some growers use plasma lamps as supplemental light in a garden, rather than investing in a full system.

Your illuminated choice

Ultimately, lighting equipment needs to be selected based on your production goals, budget, and garden design. When sorting through your decision-making, you can also turn to your friendly, local garden store as a helpful resource. Good luck in continuing to craft your growing and remember that there are many are many paths to enlightenment. •



Grower's

TIP #39

OPTIMAL WATERING AND FERTIGATION

Watering and providing nutrients in a water solution, known as fertigation, is fundamental to plant care and although this seems basic, can often be the reason for poor plant performance. Mastery of this simple task requires paying attention to drainage, volume supplied, frequency, and fertilizer rate.

When fertigating container plants with a nutrient solution, it's important to allow sufficient drainage, typically at least 20% of the volume applied. This is done in order to prevent a nutrient build up within the root zone and provides the roots with fresh, well-balanced nutrients. A well-textured substrate containing a variety of pore sizes must be used in order to support good drainage, provide for the plant, and promote a healthy micro-ecosystem within the substrate. Large pore spaces allow the solution to drain and medium pores adhere to the solution and then make it available to the plant. Very small pore spaces, like those found in clay, hold onto liquids so they drain less and are inaccessible to plants. The moisture remaining in a substrate can be helpful for maintaining naturally occurring, beneficial microbes.

The volume of water to give depends on plant species, developmental stage, and container size if applicable. Bigger plants need more water and certain species like succulents require very little water. With lush vegetative, container plants, water again when the container has reached about half its weight compared to right after watering. Try to avoid letting the plants dry out too much since this causes roots to die off, thereby decreasing nutrient uptake. On the other hand, overwatering keeps the root zone flooded and deprives oxygen, which is needed for the plant to be able to access its vital nutrients. In addition, the soggy substrate can lead to root rot and damage to the micro-ecosystem. Once you've determined the rhythm for your watering frequency, stick with it, since plants do better with consistent conditions. Take note of the effect of temperature, often impacted by your lighting and ventilation design, on your watering frequency as well.

The amount of nutrients to provide your plants, via fertigation, will also depend on plant development stage with of course seedlings and young plants requiring less than vigorously growing vegetative plants. As plants develop to maturity, put on fruits, and ripen, better flavor profiles can be developed from providing the plants with either low levels of nutrients or none at all. By doing so, the plant utilizes residual nutrients within its storage and breaks them down to a more palatable, finished flavor. The ideal water temperature for vegetative plants tends to be around 68-72°F.

Proper watering technique is crucial and it's easy to overwater or underwater while having the best intentions. Approach watering with keen awareness to how your substrate is responding and at the same time, don't overthink it and find your flow.

Good luck and happy gardening.

Don't forget to water!



Puzzle & WIN 10x

CANNAtalk wouldn't be complete without a good old Sudoku puzzle. Sit down, relax and train your brain for a moment. It's not too difficult and you could win an awesome prize! Are you new to this kind of puzzle? Here's what to do: each row, column and 3x3 grid must contain all the numbers between one and nine, once only.



WIN A 1 LITER BOTTLE CALMAG AGENT.

		7		1			4	
	9			5	6			
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			8	2			5	
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GREAT PRIZES

You might be lucky this time! Another great prize is waiting for one of you. You just have to send us the correct solution (sending the middle part of the puzzle to editor@cannatalk.com and mention CANNAtalk 39.

If we pick your name, a bottle of CALMAG could be coming your way.

Winner puzzle #37

The winner of last Sudoku is **Mr. Gabriel Kourie**. Congrats on your 1 liter bottle of CANNAZYM! We will contact you as soon as possible to make sure you receive your prize. Enjoy!



TAKING INSPIRATION FROM THE

FARMING HABITS

Fungus-farming ants rely on growing fungus for their survival. In return for tending to their crops, the ants gain a stable food supply. A new study from the University of Copenhagen, demonstrates that these ants have overcome some problems we have yet to solve.

Fungus-farming ant species started to hone their farming habits roughly 60 million years ago. Incredibly long, considering us humans only started farming around 10,000 years ago.

These ants seem to be able to grow a single cultivar species across diverse habitats, from grasslands to tropical rainforest. Relying on only one crop species can be risky. If a pest or disease gets through the defences of that crop, the whole harvest is gone. That's part of why many farmers choose to grow many different varieties and crop species.

The way ants fight off threats to their fungus is with the use of "precision agriculture". They monitor their crops closely, passing each bit of fungus in a garden multiple times a day, catching and treating problems early. This form of micro-monitoring is seen as a very valuable technique for human farms too.

Facts

THE SECRET OF HOW MOSS SPREADS

In a recent study, researchers have discovered how *Ceratodon purpureus*, also known as fire moss, has managed to inhabit every nook and cranny of the planet.

Mosses are among the oldest plant groups on earth, categorized by their lack of roots. They're incredibly resilient, being able to grow in damp and dark places and also thrive in bright and dry environments.

Researchers have discovered a connection in global wind patterns and the areas in which the moss has spread over time. This means that much of the moss you find on walls and clinging to rooftops is the same species found on a different continent at a similar latitude.

This is the first-time researchers have found such a uniform pattern of proliferation across the globe. The found knowledge may be transferable elsewhere. These findings can help with creating a better understanding of the spread of other organisms, such as bacteria, fungi and some plants, which are also spread by microscopic airborne particles. Only the future can say whether this knowledge is applicable to other organisms.



The Amazon rainforest falls victim to intensive logging and slash-and-burn agriculture, losing 78 million acres every year. The lowland Tapir could be key in recovering lost parts of the forest.

In Brazil, tapirs are known as the gardeners of the forests. This is because their diet consists of fruit from more than 300 plant species. Because of this, a tapir's belly is full of seeds. This includes larger seeds from carbon-storing trees like mess apple trees, which can't pass through smaller animals.

TAPIR POOP COULD HELP REVIVE THE AMAZON

small pieces of dung, and any seeds within, to snack on later. Interestingly, tapirs seem to spend more time in the burned areas of the forest, perhaps enjoying the sunshine away from the trees. Research has shown that tapirs deposited more than three times as many seeds per hectare in the burned parts, than they do in the untouched areas, which helps with reforestation. Unfortunately, the population of tapirs is decreasing and vulnerable. Tapirs hold a unique role in the Amazonian ecosystem that would be difficult to replace.



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CANNAtalk

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The gods must be crazy



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