CANNAtalk®

MAGAZINE FOR SERIOUS GROWERS

ISSUE 31 2015

AIR IT OUT

Plants love ventilation

FUJI ROCK

Best Festival Ever

KING OF CRUNCH

Bugs Bunny's favourites

HQTalk:

And there another year goes by! I think we say it every year but times flies! It is unbelievable that 2015 went by so quickly. Time in general goes so fast! All the intentions set at the beginning of the year have failed and the DIY in the house still is not done! Well do not worry about these now and lets celebrate the holidays!

Of course CANNA has taken care of entertainment for you on the cold and rainy days! This brand new edition is full with new growing information. In this issue you can read everything about ventilation. Growers tend to blame the nutrients when something goes wrong with their growth however most of the mistakes are made in the climate control. Ventilation is one of them and therefore we have written everything down for you which you should know about ventilation. Of course our friend sez gives you growing tip regarding ventilaiton. Next to this we tell you everything about green lacewings in the pest and diseases section, if you are a festivalgoer than definitely check the what's happening about one of the highest festival in the world; Fuji Rock.

Again enough to read for the cold and rainy days. When you have any questions and/or comments left please do not hesitate to contact us via www.cannatalk.com or the answering card at the back of the magazine.

Happy Holidays!

Karin

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VENTILATION IS OFTEN ALMOST AN AFTER-THOUGHT WHEN IT COMES TO THE DESIGN AND FUNCTION OF GROWING ENVIRONMENT. THE BEST SYSTEMS ARE GIVEN LOTS OF THOUGHT, ALTHOUGH NOT NECESSARILY A LOT OF MONEY, BUT THIS MUST ALWAYS START AT THE BEGINNING STAGES OF PLANNING A GROWING ENVIRONMENT. MOST SYSTEMS, HOWEVER, FAIL TO MEET THIS REQUIREMENT. VENTILATION CREATES AND CONTROLS THE ENVIRONMENT IN WHICH THE PLANTS AND CROPS ARE GROWN IN. AS SUCH, IT DESERVES A LITTLE MORE ATTENTION THAN IT TENDS TO GET. THERE ARE TWO PARTS TO THE DISCUSSION, THE FIRST ARE THE PRINCIPLES OF VENTILATION, THE 'WHERE, WHY AND WHAT' PART OF THE QUESTION.

By Geary Coogler BSc Floriculture / Horticulture

Then there is the practice of ventilation, putting it all together or the 'how and when' part of the discussion.
What are the goals behind ventilation? What is the purpose? Well, ventilation moves the air around - but how does this help? There are two basic types of ventilation system, which work in different ways: the first is an open system, in which air is exchanged. The second is a closed system where no air exchange occurs. Circulation refers to the movement of the air, which is a feature of both open and closed systems. Air exchange is the physical exchange of air in one defined location for a new air mass external to that location.

Circulation

Circulation basically means moving the air so that like heat and humidity are moved from one area to another. Air that sits still for any amount of time begins to separate, a process known as stratification, and this effects both

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the temperature and composition of the air. This can lead to situations such as thermal layering and shortages of critical gases such as oxygen or carbon dioxide.

Air Exchange

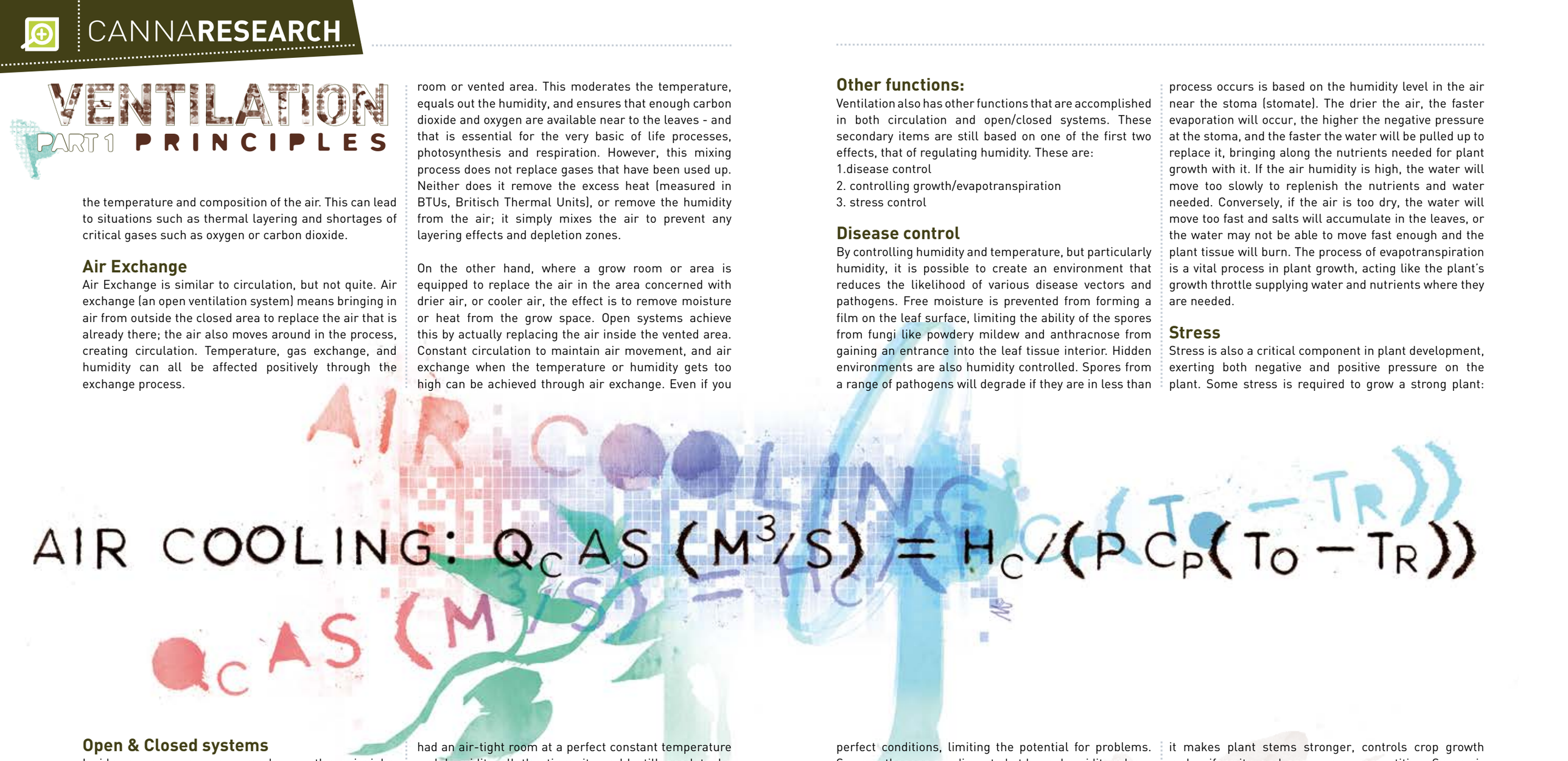
Air Exchange is similar to circulation, but not quite. Air exchange (an open ventilation system) means bringing in air from outside the closed area to replace the air that is already there; the air also moves around in the process, creating circulation. Temperature, gas exchange, and humidity can all be affected positively through the exchange process.

Open & Closed systems

Inside a grow room or greenhouse, the principles remain the same. It is all about growing plants in a controlled area. Plants need light and water to grow and survive. Plants take in light, take up water, and 'breathe' carbon dioxide plus a little oxygen and they use these four components to produce energy from light and carbohydrates, to store that energy. These carbohydrates serve as the basic building blocks for all the plant to grow and develop. Releasing the energy from the carbohydrates requires oxygen in a process known as respiration. Respiration releases energy for the plant when required. When the air is still, these processes lead to an imbalance of gases in the leaf/air interface zone, an increase in humidity close to the plant, and warmth from the light or radiant energy given off by the sun or some other light source. In a closed system, circulation serves to mix the oxygen, humidity and warmth with air further away from the plant(s), but still within the grow room or vented area. This moderates the temperature, equals out the humidity, and ensures that enough carbon dioxide and oxygen are available near to the leaves - and that is essential for the very basic of life processes, photosynthesis and respiration. However, this mixing process does not replace gases that have been used up. Neither does it remove the excess heat (measured in BTUs, Britisch Thermal Units), or remove the humidity from the air; it simply mixes the air to prevent any layering effects and depletion zones.

On the other hand, where a grow room or area is equipped to replace the air in the area concerned with drier air, or cooler air, the effect is to remove moisture or heat from the grow space. Open systems achieve this by actually replacing the air inside the vented area. Constant circulation to maintain air movement, and air exchange when the temperature or humidity gets too high can be achieved through air exchange. Even if you had an air-tight room at a perfect constant temperature and humidity all the time, it would still need to be vented regularly according to a schedule to replace the loss of the critical gases such as oxygen and carbon dioxide. What you need to understand is that even when temperature and moisture need to be raised, the effect is the same since this is based on the incoming air and will be affected up or down accordingly.

Unfortunately, when control of a single element is required, this may negatively affect other needs, so balance and priority become the watch-words. If a grower adds carbon dioxide into the grow space to increase the rate of growth, air exchange becomes harder without losing the CO_2 that has been added - a waste of both time and money. In this kind of set-up, it might be necessary to work with a priority system that gives precedence to one element over another at certain times.



Other functions:

Ventilation also has other functions that are accomplished in both circulation and open/closed systems. These secondary items are still based on one of the first two effects, that of regulating humidity. These are:
1.disease control
2. controlling growth/evapotranspiration
3. stress control

Disease control

By controlling humidity and temperature, but particularly humidity, it is possible to create an environment that reduces the likelihood of various disease vectors and pathogens. Free moisture is prevented from forming a film on the leaf surface, limiting the ability of the spores from fungi like powdery mildew and anthracnose from gaining an entrance into the leaf tissue interior. Hidden environments are also humidity controlled. Spores from a range of pathogens will degrade if they are in less than perfect conditions, limiting the potential for problems. Some pathogens are disrupted at lower humidity values, such as the group of water moulds including Phythium and Phytophthora; they may continue their activity inside the leaf, but not externally. Humidity levels also affect insects, in terms of their general survival and the reproduction rates of insects such as mites as well as less problematic insects such as fungus gnats.
Humidity also affects another area critical to plant growth and development

Evapotranspiration

The process known as evapotranspiration drives and regulates the movement of fluid, through the plant from the roots until it exits through the stomata in the leaves. Water is taken in through the roots and loaded up with nutrients and materials for plant growth. These are pulled to the top part of the plant as fluid evaporates from specialist pores on the leaf, stomata (stomates), much like water through a straw. The rate at which this process occurs is based on the humidity level in the air near the stoma (stomate). The drier the air, the faster evaporation will occur, the higher the negative pressure at the stoma, and the faster the water will be pulled up to replace it, bringing along the nutrients needed for plant growth with it. If the air humidity is high, the water will move too slowly to replenish the nutrients and water needed. Conversely, if the air is too dry, the water will move too fast and salts will accumulate in the leaves, or the water may not be able to move fast enough and the plant tissue will burn. The process of evapotranspiration is a vital process in plant growth, acting like the plant's growth throttle supplying water and nutrients where they are needed.

Stress

Stress is also a critical component in plant development, exerting both negative and positive pressure on the plant. Some stress is required to grow a strong plant: it makes plant stems stronger, controls crop growth and uniformity, and encourages competition. Some air movement, the circulatory kind that exerts pressure on the plant itself, will cause the plant to react. This is stress in action. The plant will respond by strengthening its supportive tissue as well as doing all those things that increase its odds of surviving to flower and develop larger fruits that ripen more quickly (with stronger stems to support those fruit), and increasing the metabolites that the plant normally produces to protect it and increase its potential for reproduction. Too much stress is not good, but too little stress is just as bad. Circulation of the air around the plant can help expose it to just the right amount of stress.

Geographical areas and seasons:

It may be the case that instead of an open ventilation system that depends on the exchange of air to achieve temperature reduction and/or humidity control, a closed system would work better. A closed system is

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used in cases where CO2 is replaced internally, the temperature is regulated with air conditioning units and heat is regulated using heat systems. One or all of these systems, along with a humidification and dehumidification system may well be required for most growing set-ups. In cooler areas, more heating will probably be needed, and conversely in warmer areas air conditioning will likely be a bigger concern. Dehumidification is typically required in most places; humidifiers are usually only needed in cooler areas when heating is being used, and some other more arid areas. In closed loop systems, not only does the temperature burden become much larger, all the other elements of a normal atmosphere must be monitored and maintained.

of equipment, lost production, and lack of consistency; it is certainly worth investing a little extra in some help with your design and installing a system that matches your needs first time. Even a little research into what your needs really are is certainly better than nothing.

Ventilation needs to achieve all the goals that we have already mentioned. When designing your ventilation system, keep in mind all the factors that will be affected. Where will any new air be introduced from? And where will the stale air be expelled to? How will the use of CO2 be built into a system that also requires a greater heat load during the same period? What capacity is needed for an AC system or heating system? How will this be regulated? What will the ducting look like and how will it run? These are all questions that growers need to think about. This is the only way to avoid headaches and make production easier. Putting all this together is the practical side of ventilation.

Now that we have looked at the principles of ventilation, we can move to the practice. The story continues on page 22.•

$$\text{DE-HUMIDIFY: } Q_{MD}AS\,(M^3/S) = Q_{DH}/(P(X_1 - X_2)$$

Figuring out what you need

Now the fun part: how to figure out which system and which equipment you will need to do the job. Well, short of a course in engineering, it is not going to come from a few paragraphs here. The formulations are very specific to the situation and need. Formulas for figuring out even simple steps such as the air flow rate needed for cooling (m3/s) qc = Hc/(p cp (to – tr)) may mean something to the right people but are not much use to most growers. Many factors need to be measured, such as BTU loads, design temperatures, air flow resistance, air density, moisture loads, seasonal averages, and lots more. The designer of a proper growing concern should consult widely in order to design what is needed. Making the wrong choice can cost you a lot in terms

THE KING OF CRUNCH

"IF YOU DON'T GO TO SLEEP, BUGS BUNNY WILL COME AND EAT YOU!" THAT'S WHAT MOTHER CARROT TELLS HER CHILDREN WHEN THEY'RE NAUGHTY. AND THAT'S WHY OUR MISTER CARROT IS A WEE BIT AFRAID OF RABBITS, ALTHOUGH HUMANS ARE ALSO QUITE PARTIAL TO HIS FLAVOUR. NO WONDER, WHEN IT'S SO PACKED WITH GOODNESS, GOOD FOR CLEAR VISION AND THE ULTIMATE FREE RADICAL KILLER. LET'S SAY HI TO THE KING OF CRUNCH. By Marco Barneveld, www.braindrain.nu

Bugs Bunny might scare all the poor little carrots, but he has made sure that generations of kids around the world know that carrots are great for your health. Packed with health-promoting beta-carotene, they promote good vision, especially night vision, and help combat health damaging free radical activity. Easy to pack and easy to carry, carrots are a nutritious, low-calorie addition to your healthiest way of eating, any time of the day.

Edible greens

The King of Crunch, scientifically known as Daucus carota, is a biennial herb in the Apiaceae family grown for its edible root. Not many people know that the root also produces gorgeous flowers if you leave it in the ground for the second year although very, very few carrots ever reach that stage of course. Carrots are related to parsnips, fennel, parsley, anise, caraway, cumin and dill. The foliage of the carrot plant can reach a height of 5 feet when in flower. Carrot roots have a crunchy texture and a sweet and minty aromatic taste, and the foliage is fresh-tasting and slightly bitter. Yes, you read it right. The greens are also edible, so stop throwing them away!

Carrots are packed with nutritional value, can be processed into many forms, and can be stored for months – and all this means that they quickly became a popular foodstuff wherever they were taken from their home in Iran and Afghanistan. During their journey across the centuries and continents, countless botanists have managed to improve the composition, look, flavour and size of ancient carrots.

Oh, the Dutch

We are all familiar with King of Crunch's bright orange hue, but the modern-day orange carrot wasn't cultivated until the late 16th century, when Dutch growers took mutant strains of the purple carrot and gradually developed them into the sweet, plump, orange variety that we all know

today. Before this, pretty much all carrots were purple with mutated versions occasionally popping up including yellow and white carrots.

Some think the reason the orange carrot became so popular in the Netherlands was as a tribute to the House of Orange and their struggle for Dutch independence. This could be true, but it also might just be that the orange carrots that the Dutch developed were sweeter tasting and larger than their purple counterparts, thus providing more food per plant and tasting better.

Currently, the largest producer and exporter of carrots in the world is China. In 2010, 33.5 million tons of carrots and turnips were produced worldwide, with 15.8 million tons in China alone.

Healthy little bugger

Forget about those vitamin A pills. With this crunchy orange power food, you'll get vitamin A and a host of other powerful health benefits. And I'll let you in on a little secret: carrots really are good for your eyes. It's not just an old wives' tale. Carrots are rich in beta-carotene, which is converted into vitamin A in the liver. In the retina, that vitamin A is transformed into to rhodopsin, a purple pigment necessary for night vision.

Beta-carotene has also been shown to protect against macular degeneration and senile cataracts. A study found that people who eat the most beta-carotene have a 40 percent lower risk of macular degeneration than those who consumed little. And vitamin A also helps the liver secrete bile and flush toxins out of the body, aiding any natural detox regime. The high fiber content of carrots also helps to regulate the digestive system.

And how about this? Vitamin A promotes healthier skin because it protects the skin against sun damage. A vitamin A deficiency will cause dryness in the skin, hair and nails. Similarly, vitamin A prevents premature wrinkles, acne, dry skin, pigmentation, blemishes, and uneven skin tone.

Would you like one more little tidbit on the benefits of the King of Crunch? Ok, here we go. Carrots help to prevent infection. They can be used on cuts, shredded raw or boiled and mashed. Bet you didn't know that. So are you ready to grow now?

Grow the King yourself

Carrot seeds are best planted in early spring and left till late summer, specifically February, March, April, and August and September. For the best results, carrots should be grown in sandy soil that does not retain water for a long time. The soil should also be free of stones.

To prepare your carrot patch, dig up the soil, loosen it and turn it over. Then, mix in some fertiliser. Weather, soil conditions and age will all affect the taste of your carrots. Experts say that warm days, cool nights and a medium soil temperature are the best conditions for growing carrots that taste great. Carrots benefit from a plentiful supply of moisture and should be provided with 1 inch of water each week. Mulching around the plants helps to conserve moisture and reduce weeds.

Sweet

Carrots need time to develop their full sugar content. This is what gives them their taste. If they are harvested too early, they will not have enough sugar. But carrots also lose their sweetness if you wait too long to remove them from the ground. The best way to judge if a carrot is ready to be harvested is by its colour. Usually, the brighter the colour, the better the taste. Most people do not know that carrots can be grown during the winter months. If the winter is not cold enough to freeze the ground, you can grow and harvest carrots in the same way as during the summer months. If the ground does freeze where you are, simply cover your carrot garden with a thick layer of leaves or straw. This will prevent the ground from freezing. You can remove the ground cover and harvest the carrots, as they are needed.

Reaping the harvest

Your carrots will be ready for harvesting about twelve to sixteen weeks after sowing. Harvest carrots as soon as they are large enough to use; don't aim to get the largest roots that you can or you'll sacrifice flavour. Carrots are harvested by gently digging around the plant to expose the top of the root and gently, but firmly pulling the root from the soil by grasping the top of the carrot just above the root. Carrot tops should be twisted off and the roots washed prior to refrigeration in airtight bags. Carrots may also be stored in moist sand to keep them fresh prior to use.•

FACTS

- It is actually possible to turn your skin a shade of orange by massively over consuming orange carrots.
- In ancient times, the root part of the carrot plant that we eat today was not typically used. The carrot plant however was highly valued due to the medicinal value of its seeds and leaves. For instance, Mithridates VI, King of Pontius (around 100 BC) had a recipe for counteracting certain poisons, the principal ingredient of which was carrot seeds. It has since been proven that this concoction actually works.
- The Romans believed carrots and their seeds were aphrodisiacs.
- The largest carrot ever grown was ten kilos: grown by John Evans in 1998 in Palmer, Alaska.
- Carrots are the second most popular type of vegetable after potatoes.
- The name "carrot" comes from the Greek word karoton.
- The beta-carotene that is found in carrots was actually named for the carrot itself.

RECIPE

COOK IT YOURSELF: THE SOUP OF KINGS

Can you smell that? It's the smell of carrot soup in the afternoon. If you are not growing your own yet, run off to the farmer's market and buy a bunch of crunchy kings and soup it up.

- **1 bunch medium carrots (any kind, any colour)**
- **1 onion, minced**
- **3-4 celery stalks, chopped**
- **2 garlic cloves**
- **1 red pepper, minced**
- **Chicken or vegetarian broth**
- **Salt and pepper to taste**
- **Thyme or other favorite herbs**
- **Lemon juice**
- **A little cottage cheese**

Step 1: **Sauté all the veggies in olive oil until soft. Add chicken or vegetable broth and water to cover vegetables and simmer for thirty minutes or so until soft. Add salt and pepper and your favorite herbs.**

Step 2. **Puree the soup in blender or food processor until smooth. Return to the pan and heat through. Add a dash of lemon juice and a dollop of cottage cheese. Now that's the way to treat a King.**

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.canna-uk.com, to submit your question.

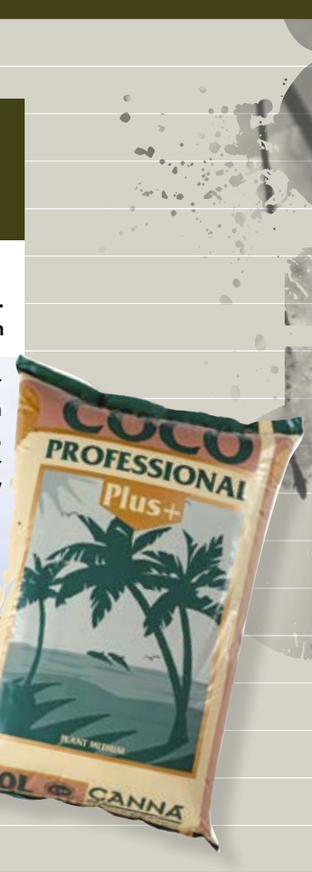
Question

I want to reuse my coco coir. The way I do this is by removing the old roots washing it with tap water and then some low EC about 1.0. Is that ok? Do I need CANNA FLUSH? What do you suggest that I do to clean it as well as possible?

Answer

Reusing coco coir is possible as long as there were no problems with your last crop. In fact, you can reuse it up to three times. You should wash the coco coir with clean water and CANNA FLUSH.

CANNA FLUSH will speed up the cleaning process, so that you will need less water to lower the EC in the substrate – and that means you can start growing again even sooner. After cleaning (the EC level does indeed need to be in the range 1.0 - 1.5), water again with CANNA Coco A/B before you start planting. Please look at our website to find out how you can recharge your coco: http://www.canna-uk.com/videos/recycling_compost.



Question

I am using the full CANNA range for my hydroponic feeding, except for CANNAZYM. I was just wondering if I could use the CANNA range supply this?

Answer

We would not recommend these products in combination with our CANNA AQUA line. You never know what else these products may contain and how they might react with our nutrients. But it is not necessary either, because CANNA AQUA already contains just the right amount of silica. CANNA RHIZOTONIC also contains the essential elements that would be present in seaweed. But in our product, these elements are always in the same proportions, so you can rely on the same effect every time you use it. You can get the results that you are aiming at using our range of products, and also, you will always get the same effects every time you grow.

Question

Would you recommend using a pH of 6.5, which appears to be optimal for soil with CANNA TERRA?

Answer

No, we recommend a pH of between 5.8 and 6.2 because the Terra range (soils) has a pH of 6.0.

The best uptake of nutrients occurs between the pH range 5.2 and 6.2, but Terra is made from peat. Peat has a very low pH so we have to bring this up with chalk. A pH of 6.5 will not break down this chalk. 6.0 is closer to the level where chalk will break down, but it needs to be slightly lower. So to keep the chalk, and also to get the best uptake of nutrients, we recommend a pH range of 5.8 - 6.2.

If you grow with a pH of 6.5, you will need to add more specific feeding elements like phosphorus and you will just have to accept that your plants look a bit pale and that your chance of the high yields is lower.

Question

Will I need to add more guano or is there enough already in the mix? Any indications on what level I should add? Or the amounts contained? I have a heavy flowering variety and I use 1.8-litre pots.

Answer

Guano is a slow-release organic fertiliser. This means that you never know exactly when these fertilisers are available for the plant.

For BIOCANNA and CANNA Terra Professional Plus, guano is not needed, because it already contains something similar (and better). These organic fertilisers act as a buffer if the grower makes any small mistakes with feeding (such as providing too little fertiliser).

CANNA Terra Professional does not contain an organic fertiliser, only mineral fertiliser (light mix). But in this case, you should supply the substrate (plant) by yourself with every watering with CANNA Terra Vega or Flores from the start, so that you are fully in control.

Question

Can you tell me how to use your CANNA FLUSH product because the instructions on your website are not very clear.

Answer

CANNA FLUSH is a product for cleaning the root zone (substrate). You need it to lower the EC level, which rises too high if you give the wrong dose. Stop watering with nutrients.

1. For one day only, give water with CANNA FLUSH, but correct the pH (the level will depend on the substrate).
2. Your next watering (when? depends on your system) should be with only water.
   For Terra and Coco the amount that the plant/pot normally needs.
   For run-to-waste (Hydro) systems, always complete steps 1 and 2 with overdrain (↑20%).
   For recirculating systems, carry out step 1 for the whole system and make sure the drain from step 2 is disposed of
3. For the next watering, if the plant substrate needs it, give nutrients and additives again, but make sure that the EC level is 0.2 lower than the last nutrient application before the excess.

During the last three weeks before harvesting, always use CANNA FLUSH once a week to prevent any excess. The plants don't need as many nutrients any more!

But step 3 is at the EC level stated in the grow guide. In the last week, reduce the nutrient dose, and in the last week do not add any nutrients at all (only the additives) see www.canna-uk.com/growguide.

Don & Nicky (PART 12)

Don and Nicky have moved back from Canada to their home country, the UK. Their search for the good life led them to France and they are now doing exactly what they wanted to do with their lives: growing. Don shares his experiences and will tell you everything about the good life in French Catalonia in this, and forthcoming editions.

I need to make my indoor garden more efficient. Last year's electricity bill nearly killed us and, as we slowly make the necessary additional payments to get our account out of arrears, the issue of my indoor garden's electricity consumption still threatens to drive a wedge between my wife, Nicky, and I who these days likens it to a second mortgage she never signed up for. She kind of has a point too.

NEWS flash

The light on the left is an air cooled 1000W DE HPS, the one on the right a 315W LEC of ceramic halide. I am mixing lights for a fuller, healthier overall spectrum

Lightmeter

In an attempt to placate her, I began to research a little deeper into how much light my plants required at different stages in their lifecycle. I wanted to see if there were any corners I could cut or new efficiencies I could find. I discovered that it all came down to something called DLI—or Daily Light Integral. Each plant species has its own light quota—a bit like the small-print calorie intake recommendations on packets of pork scratchings. "High light" crops such as tomatoes, for instance, enjoy a DLI of 22 -30 mol when mature—sometimes even more. Sweet peppers are also considered high light crops, although they are not quite as greedy for photons as tomatoes. On the other hand crops like Bibb lettuce only need 12 – 14 mol.

Mol (or moles) are a measure of lighting intensity for plants. It's basically a count of photons hitting your plants' leaves over a 24-hour period. I'd just started some determinate bush tomato seedlings and discovered that when they're young, they only require a DLI of 6 mol, rising quickly as they grow.

Now, my PAR meter measures micromols per meter per second—so, in order to determine whether my seedlings were receiving enough light, I needed to multiply this value by sixty for "micromols per minute", then multiply it again by sixty for a "micromols per hour" value, and then a final multiplication by the number of hours my lights are switched on per day—in my case, 18. This final value (a very large number) is then divided by a million to reach the DLI in mol. Easy stuff—especially with a calculator.

I decided to mount my 315W ceramic metal halide lamp on a light rail—this moved the light back and forth allowing coverage of a larger footprint. It also helped to avoid hot spot issues. However, a moving light obviously made taking accurate light intensity measurements a little trickier. I opted to hold the sensor at a given position for three minutes, take a reading every ten seconds, and then finally calculating the average. This turned out to be around 150 micromols.

Applying the aforementioned maths: 150 x 60 x 60 x 18 (divided by a million) = 9.72

In short, I was giving my tomato seedlings about 62% more light than they really needed! Conclusion? Reduce my photoperiod to 11 or 12 hours and save electricity! Day-neutral crops like tomatoes and peppers afford you considerably more wriggle-room when it comes to your chosen day length. Obviously, growers cultivating photoperiodic crops don't have this luxury.

Before long, though, my tomatoes were over a foot tall.

Not only were they screaming out for bigger pots, higher nutrient levels, larger irrigation volumes and more physical growing space, but they craved more light too! Keeping up with the exponential rise in your plants' requirements is a really important skill and one, I think, that can only truly be learned through experience.

I repotted my four best tomato plants from their intermediate 5L pots into 15L pots attached to a gravity fed system. I filled each pot with a mix of 75% coco and 25% perlite, watered them in with nutrient solution at 2.5 mS and positioned a double-ended 1000W HPS lamp above them. I had the light raised up quite high at the beginning to mitigate any transplant shock issues. Now, I know what you're thinking—1000 watts!? But double-ended HPS really is the most efficient way of producing plant usable light (that I know of) so it seemed like a good choice. I supplemented the spectrum with my 315W ceramic metal halide and created a fairly uniform spread of intense light over a 1.5 m x 1.5 m area—averaging out at around 500 micromols. At 16 hours a day, I was pushing 29 mols—a healthy amount for tomatoes entering the flowering and fruiting phase.

My next steps towards a more efficient indoor garden will include lining the walls with highly reflective material and maybe creating some movable reflective surfaces in an effort to bounce every stray photon back towards my light hungry tomatoes. Wish me luck—particularly when Nicky inevitably visits the garden and sees the 1000W HPS. It might spell the end of our joint bank account.•

YELLOW STAGHORN

DID YOU **KNOW THAT...?**

- The fruiting bodies look almost like the antlers of a stag. It's commonly known as Yellow Staghorn, although its colour is more often pale orange.
- It is sometimes confused with coral fungi, but its texture is greasier, like wax.
- Its scientific name is *Calocera Viscosa*. The prefix *calo-* means beautiful, while the extension *-cera* comes from ancient Greek and means 'like wax', so that the genus name Calocera translates to 'beautiful and waxy'.
- *Viscosa*, which is the type species of its genus, simply means viscous, sticky or greasy, and when it is wet, the Yellow Staghorn does indeed have a sticky surface.
- If you find a white example of the Yellow Staghorn you are quite lucky since these are not common at all.
- *Calocera viscosa* always grows on wood, although sometimes the substrate is not immediately evident if it is buried beneath leaf litter or moss on the forest floor. It particularly loves dead and rotting coniferous stumps and logs.
- Common and widespread throughout Britain and Ireland, this beauty is found in most parts of mainland Europe as well as in many other regions of the world including North America.
- When the weather is really dry, the colour can become a beautiful orange-red. Unfortunately this is not often the case in neither Britain nor Ireland.
- You can also eat it, you know. Although this fungus looks suspicious due to its bright yellow colouring, it is in fact harmless. But it's not really a gourmet treat either. It has a rubbery texture and not much flavour at all.
But even so, because of it's pretty appearance, it is sometimes used to garnish salads and to add colour to other mushroom dishes.

Fuji Rock

SYMBIOSIS OF **MUSIC** AND **NATURE**

We, the lucky ones, live in the age of festivals. Sometimes it gets hard to choose between all the musical greatness that we are presented with. But forget Glastonbury, forget Burning Man, forget Roskilde. If you could only visit one festival in your life, let it be Fuji Rock. The mountains are alive with the sound of music. By Marco Barneveld, www.braindrain.nu

We have a soft spot for Japan. Okay, *The Last Samurai* was a terrible movie but the samurai are an intriguing part of the history of this country. And somehow, the oldest people in the world live in Japan. And, last but not least, it's the home of sushi. And we love sushi. But we love festivals even more. And Japan is home to probably the best music festival in the world: Fuji Rock.

Dragondola

Right up in the mountains, this is a grand spot. So if you want something different this year, get your travel pants on and head off to Japan for the biggest and most beautiful of Japan's summer music festivals: Fuji Rock. This year it will once again return to Naeba, Niigata Prefectur, and will welcome around 200 bands and artists. The exact dates were not confirmed when this magazine went to the press so check out the Fuji Rock website for the exact dates in 2016. It's well worth it.

Not many festivals require a trip up a mountain by cable car to see a band. But then Fuji Rock is something really special. The twenty minutes of high wire travel in the Dragondola, the longest gondola lift in the world, to reach the Daydreaming stage is a good illustration of the festival's vast size - the largest in Japan - and its beautiful verdant setting in the Naeba resort. In winter, this is the perfect spot to try your skis or snowboard. Thankfully the outdoor Green stage is somewhat more accessible.

You might think Fuji Rock is somewhere close to Mount Fuiji, but this is not the case. In 1997, the first year of the festival, it was held on Tenjinyama Ski Resort near Mount Fuji, hence the name. It was in 1999 that the festival found its final home in Naeba. But it still retains its original name.

Disaster

It took two years for the festival to land to its current location. The first year was a massive disaster. Fuji Rock was the first outdoor rock festival in Japan and hopes were high. It was planned as a two-day event, but by sheer bad luck the first day of the event was struck by a torrential typhoon. The Red Hot Chili Peppers, who were one of the headliners, played through a storm even though Anthony Kiedis had a broken arm. You know, this is the stuff rock legends are made of. The festival-goers were poorly prepared for the heavy rain and strong winds, and many needed medical attention for hypothermia. It was just luck that no one died.

Tokyo

The guys who organised the event decided to cancel the second day, which happened to be one of the most beautiful days of summer that year in Japan. Thus ended Japan's first outdoor rock festival. The organizers were criticised for being poorly prepared for bad weather, and for not organising enough buses to link the site to the nearest train station.The second year, the festival moved to Toyosu on Tokyo's waterfront. Although the event was a success and there were no typhoons, hypothermia or organizational mishaps, many found the searing heat of mid-summer Tokyo too much to bear. The mountains are always nicer in Japan in the summer and it was decided that the next event would be held in the relative coolness of the mountains. And so it found its home on the Naeba Ski Resort, in Niigata Prefecture.

Every year, Fuji Rock aims for a *Symbiosis of Music and Nature* and take steps to alleviate the impact of the event on the environment and organize other conservation activities to benefit the future of the planet. So if you are able to get there and you buy something to eat - let's say sushi - you'll find that the plates and utensils are made from the recycled plates and utensils of the year before. Pretty cool huh?

Sparkling streams

There are seven main stages and other minor stages dotted around the site. The Green stage is the main stage and can accommodate almost 50,000 spectators. Other stages include the White Stage, the Red Marquee, Orange Court, and Field of Heaven. The walks between some of the stages can be long, and some of the trails can be hilly, but the walks are beautiful, often taking you through forests and over sparkling streams. The line-up for 2016 has not been published yet, but is of excellent quality every year. For example, last year it played host to headline sets from rock behemoths Foo Fighters and Muse. You could have also been witness to brilliant acts by Deadmau5, FKA Twigs, forgotten rock genius Todd Rundgren and Belle and Sebastian. Plus sushi - lots and lots of sushi! But don't worry, they'll have a new supply of that delicious sushi when you get there this summer.

When: Check fujirock-eng.com
Festival heaven for: Headbanging mountain climbers.•

Pests & DISEASES

Figure 1: Eggs of the Green Lacewing

Even though this series of articles is called Pests & Diseases, this time we have decided to look at a natural predator of common pests or beneficial insect – the opposite of a pest. Beneficial insects, or beneficials for short, are insects that kill and control pests on crops. They can be naturally occurring or puchased and introduced into the infected crops. The use of beneficials is a form of organic crop protection and integrated pest management (IPM). In a future article we will explain IPM in more detail, but now we will focus on one of the lesser known but very effective beneficials, the green lacewing.

By CANNA Research

BENEFICIALS

GREEN LACEWING

Green lacewings are insects in the family Chrysopidae of the order Neuroptera, or net-winged insects, which also includes mantidflies, antlions, and their relatives. There are approximately 85 genera and 1500 species of Chrysopidae around the world. Members of the genera Chrysopa and Chrysoperla are very common in North America and Europe. There are also Brown lacewings but they belong to a different family, the Hemerobiidae.

Appearance

Green lacewings are generalist predators and are commonly found in agricultural landscapes and garden habitats. They are delicate insects with a wingspan of between 6 and over 65 mm, though the larger forms are found in tropical regions. Adult green lacewings are soft-bodied insects with four transparent wings which have an interconnecting network of fine veins, golden eyes, and green bodies. Adults often fly at night and are drawn to lights. Adult green lacewings are divided into two diet categories: some species of green lacewing adults are predatory, while others feed only on honeydew, nectar, and pollen.

Lacewing larvae are pale with dark markings and look like tiny alligators. They are somewhat spindle shaped, with two sickle-like jaws protruding from the head. The body is covered with many tubercles with bristles.

Lifecycle

Adults are attracted by the odour of aphid honeydew and lay their eggs near aphid colonies. The females produce 400-500 tiny oblong eggs each. Eggs are laid singly in some species, such as the common green lacewing Chrysoperla carnea, while other species lay in clusters. Eggs are suspended individual at the tops of threadlike stalks to protect them from predation by hatching siblings. The eggs are green when laid, but they darken before hatching. Lacewings undergo a complete metamorphosis with eggs hatching about 4 days after being laid, and the larvae develop through three instars.

After this, they will pupate by spinning a cocoon with silken thread. The adult emerges from the pupa within about 5 days through a round hole that it cuts in the top of the cocoon. Lacewings overwinter as a pupa within its cocoon or as an adult, depending on the species.

Use

Lacewings (both green and brown) are important predators in many agricultural systems worldwide. The common green lacewing (Chrysoperla carnea) is the most commonly used and commercially available species and naturally controls many different pests.

Since the adults of the common green lacewing are not predatory, companies either sell eggs or larvae. Some companies also sell adults but since they can easily fly away, they are less effective. The eggs of the green lacewing are shipped loose in an inert medium of rice hulls, for example. The rice hulls facilitate the proper placement of the eggs.

The larvae are highly cannibalistic and must be separated in transit. This is accomplished by means of a frame or hexcell unit. The hexcell unit is comprised of many small compartments which can be opened one row at a time when releasing the predators. Some companies sell the larvae loose in a bottle with buckwheat hulls that provide hiding places.

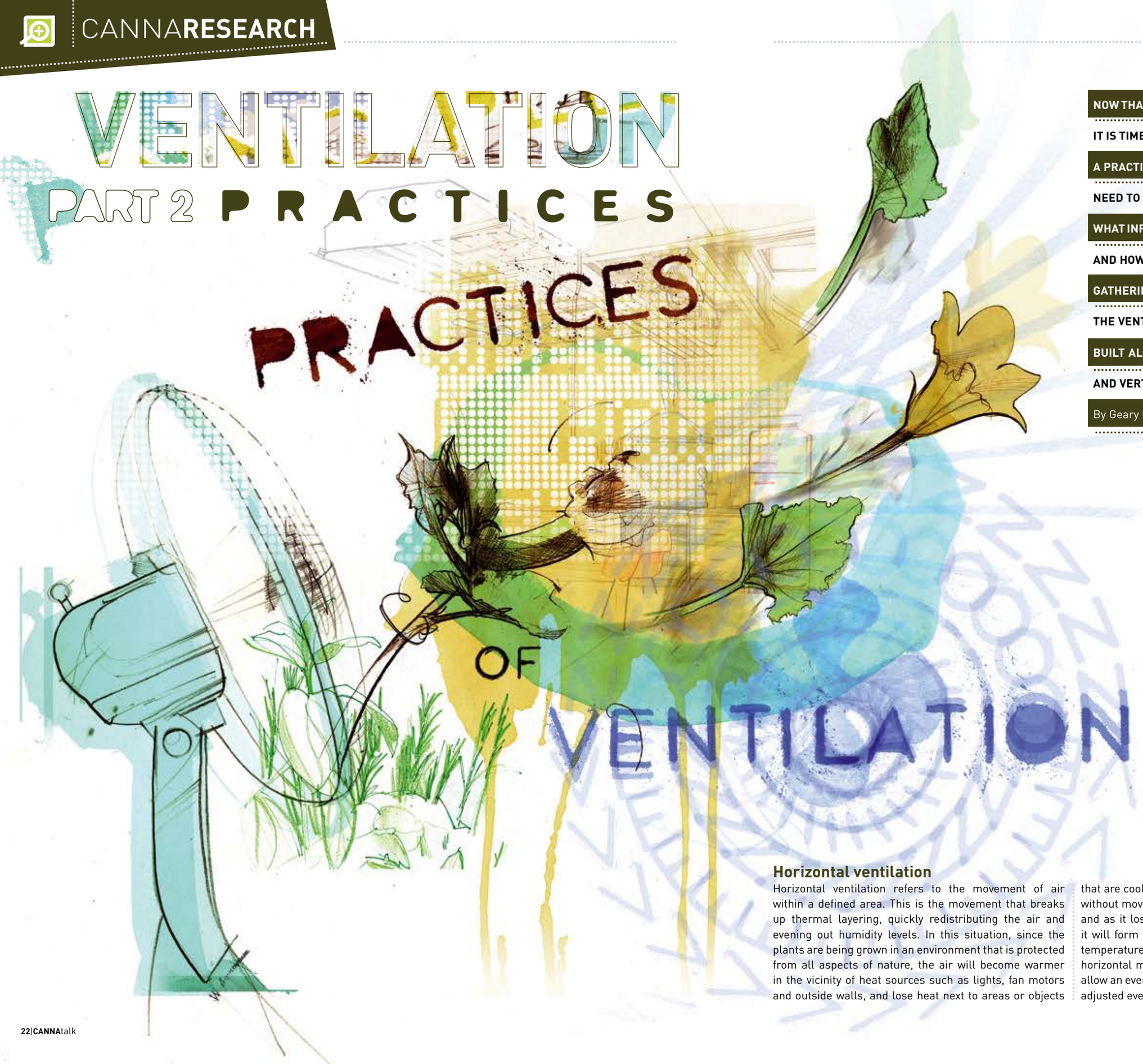
The larvae need to detect their prey through direct contact. Their senses are weakly developed, but they are very sensitive to touch. Walking around in a haphazard fashion, the larvae sway their heads from one side to the other. When attacking prey, the larva lunges forward, impaling the aphid. Enzymes are injected through its hollow jaws. After the prey's body contents have been digested, the mixture is sucked back through the jaws of the lacewing larva. The long tail section is used as a stabilising brace when the larva is attacking prey.

The larvae is also known as the "aphid lion" or "aphid wolf" because of its voracious appetite. Besides aphids, they feed on just about any soft-bodied pest they can get their jaws on, including citrus mealybugs, cottony cushion scale, spider mites, thrips, caterpillars, insect eggs, etc. They are known to be cannibalistic when no other food source is available. During the two to three weeks that the insect spends in this stage in its life cycle, it will devour up to 200 victims a week. •

Figure 2: The common Green Lacewing

Figure 3: Larva of a common Green Lacewing Chrysoperla Carnea feeding on an aphid

VENTILATION PART 2 PRACTICES



NOW THAT WE HAVE SEEN THE BASICS PRINCIPLES, IT IS TIME TO DISCUSS THE DESIGN CONCERNS FOR A PRACTICAL SYSTEM. THE FIRST THING THAT YOU NEED TO KNOW IS WHAT YOU ARE DESIGNING FOR, WHAT INFLUENCES THERE WILL BE ON THE SYSTEM AND HOW THESE WILL CHANGE OVER TIME. AFTER GATHERING ALL THE NECESSARY INFORMATION, THE VENTILATION SYSTEM CAN BE DESIGNED AND BUILT ALONG TWO SEPARATE LINES: HORIZONTAL AND VERTICAL VENTILATION.

By Geary Coogler BSc Floriculture/Horticulture

Horizontal ventilation

Horizontal ventilation refers to the movement of air within a defined area. This is the movement that breaks up thermal layering, quickly redistributing the air and evening out humidity levels. In this situation, since the plants are being grown in an environment that is protected from all aspects of nature, the air will become warmer in the vicinity of heat sources such as lights, fan motors and outside walls, and lose heat next to areas or objects that are cooler, known as sinks. If the air is allowed to sit, without moving, the air that has acquired energy will rise, and as it loses energy, it will slowly sink. In the process it will form layers of air molecules that are at a similar temperature. This is termed heat stratification, and horizontal movement is required to mix these layers and allow an even temperature in the growing area, that can be adjusted evenly to cool or heat as the need arises.

VENTILATION
PART 2 PRACTISES

Removing micro climates

The leaves of the plant have micro pores located on their surface, through which the water transpires. This is what drives the movement of water from the roots to the top of the plant and moves nutrients internally within the plant. Plants use both oxygen and carbon dioxide, which move in and out through these pores. It is possible, when there is very little air movement, for a build-up of these gases trying to move in and out at the same time. These micro-climates (also known as barriers) have to be eliminated to allow the plant to develop at the optimum rate. Horizontal mixing of the air in the grow room eliminates these micro-climates, increasing the efficiency of the movement of these gases in and out of the leaves.

Requirements

The requirements for horizontal air flow are simple to define but less simple to achieve. The air in the growing area, the area occupied by the plant(s), is the target that needs to be moved. Moving the air in the rest of the room is a good idea but air circulation near the ceiling will add to the heat load since most of that air is warmer than in the growing area, and the floor is liable to harbour more fungal spores or insects. How the air is moved will determine the stress on the plants. In the end, there are really two ways to induce this air flow, the first being the use of air currents produced when removing and replacing the air in the room and the other through a separate, dedicated device such as a smaller fan or the newer high-efficiency horizontal fans (HFs) that are designed to create a small vortex effect in the target zone. The fact that the air exchange air flow is not constant if it is also used to regulate temperature, and the need for horizontal air flow 24 hours a day throughout the crop cycle, means that a separate device is required.

Speed of air movement and distribution

The amount of power needed to change the air in a room several times a minute for cooling purposes will cause air currents that are too strong and can easily cause excessive stress and possibly damage to the plants. When using both a horizontal system and a vertical or exhaust system, there can be a cumulative air pressure/speed effect that must also be monitored. The ideal speed of circulation should produce a gentle movement of all leaves in the grow zone. This will ensure proper mixing of the air without stressing the plants too much. Where possible, use two wall-mounted fans in smaller areas that are placed at the level of the plants and face in different directions. This will create a rotation in the air mass which allows for the best distribution in the grow zone. In bigger areas, HF fans create a strong force but smaller volume so that, while being very effective at creating localised circulation, this will not be strong enough to impact the plants directly. These are usually placed so that the air flow from the fan is directly above the top of the plants. Creating a stronger vortex just above the plant tops creates the gentle movement in the leaf zone that is desired. This type of action is really

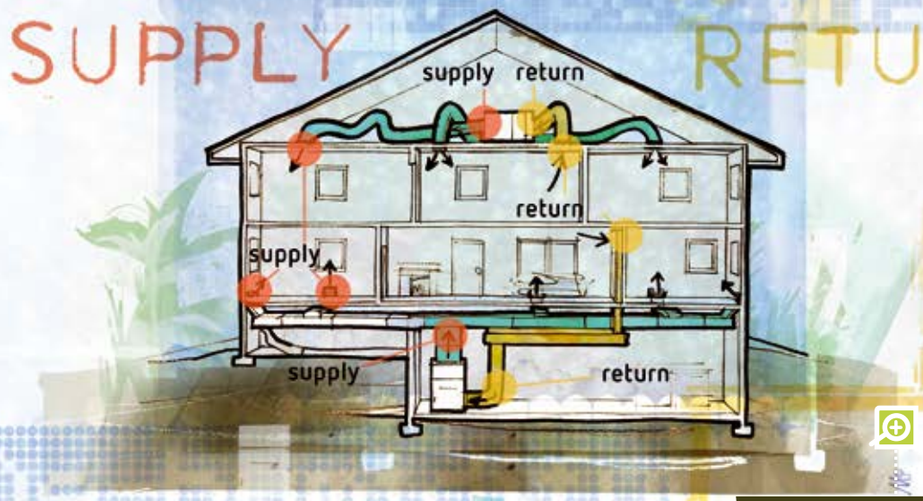


Figure 4: Air supply and return in a house

impossible with the vertical systems which must also be designed to move all the air in the room or area not just that located in the growth zone.

Vertical Ventilation

Vertical ventilation is a term used to mean that air that is moved out of the grow area and treated, before being returned or replaced by air from another location. Unless the system is designed to supply and extract the air to and from the floor and ceiling, all air flow is horizontal, so the implication in this system is that air is moved across several levels and not across the same level. The air in an area used for plant production must be changed on a regular basis in order to avoid a whole range of issues. Changing the air alters the temperature and humidity, and replaces the gases that are being depleted in an air-tight space, such as carbon dioxide. Although horizontal ventilation will mix the air and therefore moderate temperature, humidity and gas ratios by mixing the air across the entire room, it will not remove or add heat, humidity or replace the gases that have been used up. Air exchange is the only real answer.

Open and closed systems

There are two ways to implement a vertical system: either open, meaning that either the system draws in air from a different area which replaces the air in the target area; or closed, meaning the air never actually leaves the growing area and is treated in situ. Treating the air - cooling or heating it, humidifying or dehumidifying it, and replacing depleted gases - is important in both systems, but is absolutely essential in a closed system. Depending on the need to regulate the environment in the growing facility and the needs of the crops produced, the air movement through exchange, in either an open or closed system would determine the exact design of the system.

Closed systems

A closed system will be used in situations where contamination, either biological or environmental through ozone or other industrial pollutants, must be avoided; contact between the air in the interior and the exterior is carried out separately. The area air is removed, treated and returned to the area.

Open systems

An open system draws its fresh air supply from an exterior source such as a controlled room or the exterior. It can be used directly to cause a change in temperature, humidity, and gas content, or it can be treated to cool, heat, humidify, or dehumidify the air before it is supplied to the growing area. This air is then drawn through the area to remove the old air, at a rate that can make a difference. While it is drawing the stale air out of the room, the factors that have brought about the undesired change in temperature or humidity continue to occur. The rate at which this new

VENTILATION PART 2 PRACTISES

air can rectify these continuing undesirable effects and remove those that have already built up will determine the rate of air exchange required. This must also occur fast enough to make a difference. There are formulas for calculating humidity and heat loads and the flow rates that are needed to cause a change.

Designing the system

The designer needs to understand what the heat gain or loss for the area is, usually calculated in BTUs or British Thermal Units. Once the required number of BTUs is known, the designer can build a system that will be able to maintain a steady set of values in temperature and/or humidity based on the difference between the worst case scenario and the parameters that conditions must remain within.

Temperature

If the indoor temperature under lights in the summer will reach a maximum of 49° C and the maximum temperature at which the plant should be kept is 32° C, then the system must be able to alter the temperature by a differential of 17° C. Heating can be measured in a similar way, and humidity too, although it is calculated differently.

Gas ratios

Gas ratios in an open system are not really an issue as the ratios should always match what is available outdoors, which is always sufficient. In a closed system, it will be necessary to add carbon dioxide during the periods when photosynthesis occurs, since the existing CO_2 will be used up in a very short space of time, so fast as to begin to slow down the plant's metabolic processes within a couple hours. Oxygen, on the other hand, while also needed by the plant at normal life levels, is released in heavy enough concentrations during the fixing of the carbon in the CO_2 to supply what is needed.

Which components?

The exact requirements of the system will determine which components will be used. In a closed system, the ability of the environment will determine whether an evaporative cooling system would work well enough or an HVAC unit will be required. The need to move a certain volume of air will determine the size of the ducting and the fans. Open systems work either by drawing in air from the outside into the target area. If the air needs to be cooled and humidified, an evaporative cooling system might be an answer (known as swamp chillers, in some locations, and which can also be used in a closed system). The calculations for these types of systems should be carried out accurately to ensure that a system is both functional and cost-effective. All the factors that would affect a system must be known, and that includes restrictions such as bends in the ducts and any filters used. It is also usually critical to use fans on both the exhaust and input sides to ensure good air movement and balance the pressure in the room.

Controls

Controls for the automation of these systems are also a big concern and cannot be forgotten in the rush to finalise a system. Unless the grower or a grower's representative can afford to watch a thermometer, a hygrometer, and a CO_2 monitor 24 hours a day for months on end, a device to control the operation of the vertical ventilation based system will be needed for either an open or closed system. The horizontal system tends to remain active all the time so a controller is not necessary other than an on/off switch. The minimum that any system will need is a thermostat to regulate the cooling system. A separate thermostat will be needed to regulate a heating system that may be linked to the vent system. In tight rooms used for growing, a humidistat is also a great idea, one that operates the vent system when humidity rises above a certain specified level. It might also be desirable to be able to set different values for a night cycle, especially for temperature. Some systems, especially at certain times of the year, may require cooling during the day and heating during the night, especially in greenhouse environments.

In closed systems, where certain gases like CO_2 are released to supplement or raise ambient levels, a gas monitor is also a good idea, especially one that triggers an alarm if the regulation of the gas fails. Adding CO_2, while positive for the crop, can be costly and will be less effective if too much is used. It also becomes dangerous to employees and growers if levels rise too high when people are present. A CO_2 controller adds value by ensuring that the ventilation pattern never exhausts the gas or that it is added at a certain time in a system that regulates temperature or humidity.

Keep it simple

Everything needs to work together in order to be effective. It is always best when controls can be integrated into a single or dual set of controls. It must also be understood that the KISS principle applies here as well, and the smaller the growing room, the less complicated the system should be. The simpler the controls, the less chance of error or failure. Temperature, humidity and gas injection are controlled by the use of set points so that, when a grower requests, say, a 22° C temperature for cooling, the system will switch itself on when the temperature rises a few degrees above this and run till it gets a few degrees cooler. This allows the system to work more efficiently; very precise control is not needed and will cause the system to constantly click on and off within a single degree or less of temperature change.

Ventilation is certainly not the easiest aspect of growing, but it is an essential aspect of controlling the growing environment for the benefit of the plants. It cannot be neglected in the rush to produce and is fundamental within the overall design of the grow space. Proper care must be taken when designing the installation to ensure functionality... and functionality means success!•

Grower's TIP #31

By your friend SEZ

VENTILATION

When growers ask us for advice to increase their yields, the first questions we ask are usually climate related. Knowing that 96% of dry plant tissue is composed of Carbon, Hydrogen and Oxygen; Climate control is undoubtedly a major factor for high yields.

You will first need to determine the volume of air to be exchanged in your grow room(s) to properly chose your ventilation equipment. Then when it comes to fans, there are many different brands and models on the market. Not to mention the hordes of copycats that mimic looks that rarely provide the power of the originals. For your garden to perform, you need to move air, not dreams.
Serious growers always favour products certified by credible HVAC associations along with safety and quality control firms like CSA, ETL or UL. If there is a malfunction with any equipment related to climate, it can have disastrous consequences on your yields. Don't cheap out, you might lose way more than you saved!

Three things to consider when setting up your ventilation system:

1st: The CFM number on the front of the box means NOTHING!
That CFM number is usually the maximum measured value obtained at 0 in. wg (zero inches water gauge), meaning no air restriction at all. But this value is useless in the real world, because the air flow will always be restricted due to the ducting, elbows, dampers, etc. Serious fan manufacturers will provide charts indicating the real CFM values in relation to air restriction (in. wg). These charts are the only way can you really determine which fan size and power you really need. A good idea is also to get fans with more power than is really needed, as it's easy to turn down a fan but impossible to make it stronger.

2nd: Size does not always mean performance.
The power of the fan's motor will greatly influence the output of your ventilation set-up. You might find two fans of the same size, but one with an 180W motor and the other with a 280W. While both fans may advertise a similar CFM number, only the second one will maintain a decent output in real-world conditions.
Think of it like two Ford mustangs, one with the basic 4 cylinder engine and the other with Ford's legendary 5.0L V8. Both will be able to cruise at 100 miles per hour on flat prairie lands, but only the 5.0L will keep that speed going uphill in the Rockies.

3rd: Plan properly.
Keep in mind that each turn your duct run takes has an impact on air movement. Make sure there will not be any unneeded twist and turns and install your ducting as straight as can be.
If energy conservation is a factor, you might want to consider going for the newer 'Mixed Flow' fans that, compared to older centrifugal models, are more compact, more energy-efficient and more powerful.
Comparison of centrifugal and mixed flow designs*

FAN MODEL	RPM	MAX WATTS	CFMs remaining after air restriction (in. wg)								
			0"	0"	.125"	.25"	.375"	.5"	.75"	1.0"	1.25"
Centrifugal 10"	2760	283	761	761	734	701	665	629	568	505	435
Mixed Flow 10"	2990	228**	1019		985	950	920	885	815	705	535

*Both fans from the same manufacturer **Note how mixed flow designs give more CFMs while using less power
Finally, make sure your equipment for measuring and regulating the climate is properly positioned in the garden to accurately assess the conditions where the plants are. You should opt for digital controls with remote probes and sensors that can be placed within plant canopy, where it really matters, rather than wall-mounted models.

Good luck and Happy gardening

Puzzle&WIN

This 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 OF CANNA RHIZOTONIC

			3		5	2		9
	4		9	2		8		
3					8	5		7
	5	8		7				
				5		1	7	
6		4	1					3
		5		4	9		8	
9		2	5		6			

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 I enough for us to check), and if we pick your name,

A BOTTLE OF RHIZOTONIC COULD BE COMING YOUR WAY.

Winner puzzle#29

The winner of last Sudoku is **Mr. John Potts.** Congrats on your 1 liter bottle of CANNA PK 13/14! We will contact you as soon as possible to make sure you receive your prize. Enjoy!

WHAT'S NEXT

The next edition of CANNAtalk will take a close look at two things that most of us growers have been doing for ages, but never knew exactly how. First, our research team will explain everything about taking cuttings. Just taking a pair of scissors isn't enough. Next we'll tell you about watering plants, one thing that can make or break any grower. But how do you get it exactly right? The frequency and the amount of water depend on many outside variables, making this quite a complex subject. Want to put your knowledge into action? The Grow It Yourself is all about rhubarb.

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Whatever it is, we would like to hear from you. We love to read your comments and find out what issues our readers are facing. So don't hesitate to get in touch!

Write your answers to the puzzle, your comments, questions or suggestions on the answering card (we'll refund the postage). You can also visit our website or send us an e-mail at info@CANNAtalk.com.

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- ☐ TERRA Fertilisers (potting mix)
- ☐ Additives (Optimizing your yields)
- ☐ List of shops in my area
- ☐ Send me a CANNA Calendar 2016. I've secretly enclosed 10 pounds in this envelope to pay for it.

Solution to the puzzle:

#31

SERIOUS GROWERS

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