

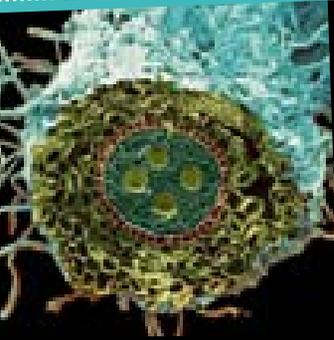
# CANNAtalk<sup>®</sup>

MAGAZINE FOR SERIOUS GROWERS

ISSUE 20 2013

## ROOT ZONE TEMPERATURE

The temperature story



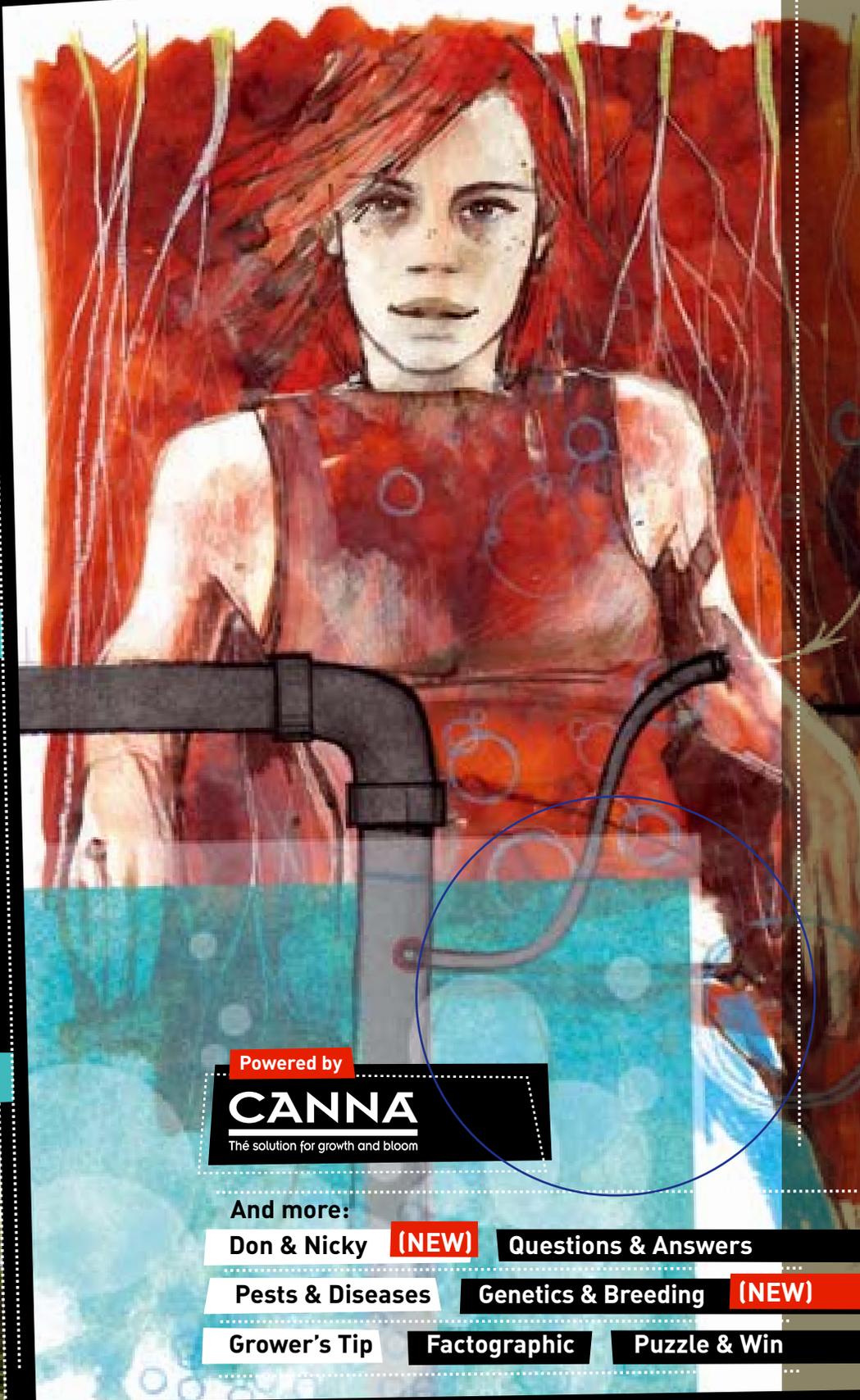
## REMARKABLE GETAWAYS

Enjoy your dream!



## PARSNIP

Tasty and newly hip



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The solution for growth and bloom

And more:

Don & Nicky

**(NEW)**

Questions & Answers

Pests & Diseases

Genetics & Breeding

**(NEW)**

Grower's Tip

Factographic

Puzzle & Win

# DON'T WORRY BE HAPPY!



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## HQ Talk:

Over the last few years I've been in regular contact with Don and Nicky, both of whom have a passion for growing and cultivating. I love to hear their inspiring stories, and even more so now that they have moved to France. I'm sure that I'm not the only one who enjoys their stories, so I'm delighted that they are willing to give CANNAtalk readers a little peak into their life starting in this issue. And we have another very interesting item called 'Genetics and Breeding'. I have noticed that our researchers can write pages and pages on this theme, because there is so much to say about it! In this edition, you will read about the basic rules of plant breeding based on the rules of Gregor Mendel, the father of modern genetics. In the next issues, themes like phenotypes and genotypes, day-neutral plants, and flowering will be covered.

Enjoy reading!  
Jeroen

**A ROOT ZONE ISSUE WITH MORE PAGES AND NEW ITEMS**

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# IS IT WORTH USING

# AIR

# INJECTION IN YOUR NUTRIENT TANKS?

OVER THE LAST SEVERAL YEARS, AN INCREASE IN THE USE OF AIR INJECTION SYSTEMS DESIGNED TO INCREASE

THE OXYGEN CAPACITY OR CONTENT OF STORED AND UTILIZED IRRIGATION SOLUTION HAS SEEN MAJOR GROWTH.

SEEMS EVERY GROWER HAS OR IS CONSIDERING THE USE OF THESE SYSTEMS IN THEIR OPERATIONS, BUT WHAT

ADVANTAGE IS THERE? WHAT ARE THE REASONS FOR AND AGAINST THE USE OF THESE SYSTEMS AND UNDER

WHAT CONDITIONS SHOULD THEY BE USED? AN EVEN BETTER SET OF QUESTIONS IS WHY ARE THEY USED AND

WHAT HAPPENS TO THE SOLUTION WHEN THEY ARE USED?

By Geary Coogler, BSc Horticulture

## The basics of water

To begin, water not only holds the water molecule H<sub>2</sub>O, but additionally it holds dissolved solids that can range from good things for plants like calcium and iron, but also not so good things like sodium and lead. It also

can hold dissolved gasses such as oxygen and carbon dioxide. The warmer the water is, the less of these gases it will hold. The higher the concentration of dissolved solids like nutrients, the less gases will be held. When

water moves and is kept in a stirred state so that it is being exposed to the atmosphere, these gases will stay in a fairly stable state. When water sits still, these gases begin to leave the water by rising through the column of water so that there becomes a deficiency at the lower levels but increasing towards the top. This is the process of stagnation. While many changes can begin to occur in this stagnating water column, it is not in the scope of this article or important to it. It is, however, the main reason water is aerated.

While these gases are present in the water, they can affect many things including the physical and ionic states of the elements present in the water and the pH of the water. Carbon dioxide (CO<sub>2</sub>) as it moves through the water column reacts with ions like calcium and will begin to raise the pH as carbonates form. Most public drinking water supplies take advantage of this mechanism by adding calcium carbonate to the water which serves as a pH buffer that both provides better tasting water and protects the pipe systems from excess pH issues both high and low. In this case a buffer will offset pH changes from either acid forming compounds

or basic forming compounds that might be present in the water so that the pH remains constant for the time the water is stored and delivered to the outlet.

Additional reactions can also occur from other gas in the water including oxygen. Oxygen is an oxidizer and as such, will combine with ions in the water to form new compounds. These new compounds will likely fall out of solution or become unavailable for plant usage. This is very important when these gases are present in ion rich irrigation water that is used to fertilize with.

## Why dissolved air is important

The atmosphere is made up of many different gases and some of them will dissolve into water. Dissolved air in water is important because it both sustains and prohibits life. In this situation, the important gases are oxygen, in the diatomic form O<sub>2</sub>, and carbon dioxide, CO<sub>2</sub>.

Oxygen has to be in the diatomic form to be useful for life. Oxygen in the form of O<sub>2</sub><sup>-</sup>, the reactive form, also known as free radicals, are detrimental to all carbon based life forms because it is looking for something to combine



Figure 1: The decision to diffuse air into your tanks depends on many variables. But diffusing air into a tank will only work when the plant can adapt to the lower concentrations of oxygen available to the roots and still function well enough to supply the top.



# AIR INJECTION

with and carbon is the optimal partner. Oxygen, as  $O_2$ , is the oxygen source for life found in the water in the way of both plants and animals. Peroxide compounds do not work here because the oxygen released is the reactive free radical as  $H_2O_2$  converts to  $H_2O + O_2$ . Carbon dioxide is, of course, not required by the root system but is required to influence pH by slowing down these fluctuations.

Without oxygen, a nasty form of life that is anaerobic is favored and will develop, and can be the causal agents for stagnation and the associated smells as well as toxins that can be released and a plethora of diseases. Roots from the plants that grow in a medium of water still have to have oxygen, at correct levels, to function properly. Not only roots but also other beneficial microorganisms require the availability of oxygen to survive and/or thrive. However, the levels that they require can differ from terrestrial plants. Terrestrial plant roots seldom see ambient air concentrations as air must

diffuse through the pore structure of the soil, but it does remain much better than oxygen levels typically found in water.

It is very important to note that different gases dissolve differently in water than in air. For instance,  $CO_2$  readily dissolves in water but oxygen and nitrogen not so readily. Water will only hold so much total gas, which means that as more  $CO_2$  dissolves, other gases such as oxygen and nitrogen are driven out of the system. Also, as temperature or salinity rises, a disproportional amount of the less readily dissolved gases will come out of solution faster than the more readily dissolved gases such as  $CO_2$ .

### When should water be aerated and how?

There are two basic ways for air to get into water: by dissolving from the atmosphere under normal pressure and by being forced through the water (oxygen diffusion).

While some fish and aquatic plants can extract enough oxygen to survive at concentrations around 5 ppm, terrestrial plants cannot. Plants that are typically land based will require special effort when grown in a water medium. A distinction must be made in whether a plant will be grown in a water medium, or just exposed to water on occasion (deep water culture verses all other).

In deep water culture or Aquaponics, for terrestrial plants, the level of oxygen must be increased beyond what would be absorbed by simple water stirring. Depending on water temperature and salinity levels, this could be a difficult task and the need for oxygen diffusion comes into play. Some risks exist in this system especially if the environment the air is drawn from is  $CO_2$  enriched. This will cause fluctuations in pH mostly upward as the  $CO_2$  combines with calcium. The additional effect is that less  $O_2$  will be entrained as  $CO_2$  dissolves readily and displaces  $O_2$ . Care should be taken to pull from an outside source. Watch the pH. It will fluctuate and the more available the nutrient package is, the faster and more pronounced this will occur.

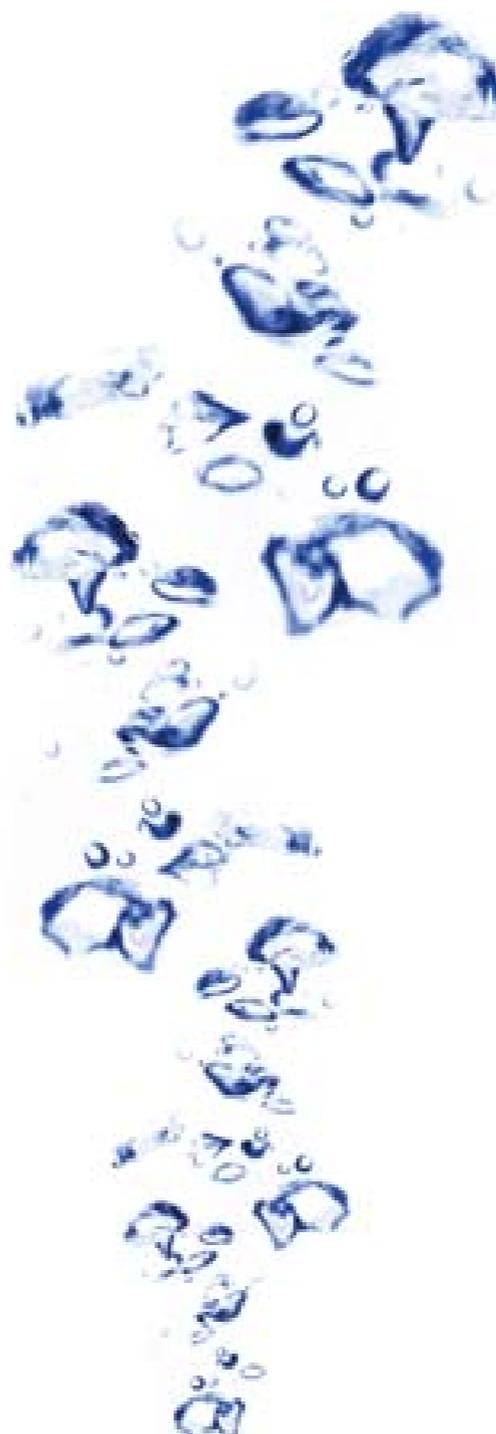
In all other systems where water is applied then stopped while what was applied drains away, including clay pebbles, rockwool, sand, soil, peat, coco, or anything else where the roots do not actively sit in water 24/7. Aeration for oxygenation does not have to be at Aquaponics levels, and what will absorb into the water naturally with perhaps some stirring action on long term tank preparations, might do just fine. This will help avoid stagnation, keep appropriate  $O_2$  levels for life, and keep the pH from swinging uncontrollably especially where the tank is located in a  $CO_2$  enriched atmosphere. Additional oxygen for the root health may not be needed because the action of the water draining will pull air into the pores of the medium and provide the appropriate levels of  $O_2$  to absorb into the film of water on the root surface. Most of the oxygen in the water will not really be used since it will not stay long enough to be absorbed except from the solution on the root surface.

Also, roots not living in water are not the same as roots that live in water; there are differences in things like the thickness of the pericycle which controls the amount of

## STILL WATER process of stagnation



Figure 2: When the water in the nutrient holding tank is left still, the dissolved gases begin to leave the water by rising through the column of water so that there is less dissolved gas at the lower levels, with more towards the top.





# AIR INJECTION

water that moves into a plant. Exposing roots that are not water developed to water saturation for longer than twenty minutes will kill the root.

Hybrid systems such as ebb and flow (flood and drain), the act of pumping the water up onto the table then the flow back into the holding tank is sufficient to keep enough dissolved gases in the overall system. In environments with supplemental CO<sub>2</sub> at high rates, this can still cause a larger amount of CO<sub>2</sub> to be dissolved into the water with similar results as air injection. However, it is nowhere near as rapid as the physical bubbling of air through the solution will cause. Care must be maintained for pH issues, and tanks changed more frequently than would probably be required in non-supplemented rooms.

So, in systems that do not involve keeping the roots submerged at all times in water, including systems that allow some water to be held in the medium against gravity but away from the root, it is best to limit air pumps and injection systems, because oxygen in this system will mostly come from diffusion in the medium after irrigation: a simple system that allows for the water

in the tank to stir for a few minutes every hour or so, will handle the needs of the system. This can be as simple as a diverter on the plumbing for tank pump that directs a small amount of the pumped water back into the tank. Other devices could include mechanical stirring equipment such as is employed in the construction industry for paints and other mixing functions.

In true hydroponic systems with an inert medium that holds little water, such as clay pebbles or Nutrient Film Technique (NFT), then having O<sub>2</sub> concentrations at or above 40 ppm are required, getting to 60 ppm, which is better, may require much entrainment of air, and as such will have to be monitored closely. However, it does not have to come all from a diffuser. Aquaponics, because the volume of water will not be conducive to allowing appropriate O<sub>2</sub> levels naturally, will have to be diffused with O<sub>2</sub>.

Air is an important component in irrigation water for sure, but control is critical to avoid upsetting the balance of the system. The real question is if the effort being made is over-achieving the need and causing more issues than benefits. The grower should be smart about what is needed, what results can be expected, and what the true costs are. If stagnation is an issue for the grower even with the simpler techniques mentioned here for any system but total root submergence, then the answer may well be a smaller holding tank with more frequent renewals. •



Figure 3: An air pump.



# Grow IT YOURSELF



Figure 4: Before sowing parsnips, make a shallow drill in the soil about 1 inch deep. After sowing the seeds, cover them with soil and then firm down. Water the area if the weather is dry. Germination takes approximately three to four weeks.

# IT'S HIP TO GROW PARSNIP

**PALE YELLOW, KNOBBLY AND UNEVEN, WITH LEAVES THAT CAN CAUSE SERIOUS IRRITATION. NO WONDER THE SWEET PARSNIP WAS OFTEN OVERLOOKED IN FAVOUR OF ITS MORE ATTRACTIVE COUSIN THE CARROT! EVEN IN THE WORLD OF VEGETABLES, LOOKS DO MATTER. BUT NOW IT'S TIME FOR A COME-BACK... PLEASE WELCOME THE STILL PALE BUT NUTRITIOUS, TASTY AND NEWLY**

**HIP PARSNIP!** By Marco Barneveld, [www.braindrain.nu](http://www.braindrain.nu)

It was decadence that brought down the Romans, history teaches us. It was definitely not the food, although sometimes that decadence took the form of great orgies of culinary madness. Parsnips were a luxury item for our Roman ancestors. In Rome, they used to be smaller, though – the plant was originally the same size as a normal carrot. But as the Roman armies moved further north, they took the *Pastinaca sativa* with them. And you know what? The parsnip grew much larger in colder regions. Being exposed to the freezing cold actually makes parsnips taste better. That is why most people wait with harvesting them until, after the first frost has bitten. Our parsnip was largely popular in the middle ages. It was easy to grow, plus you could store it for a longer



Photo Courtesy Peter Stevens

# PARSNIP



period – the ideal foodstuff before they had fridges. But then, in 1536, the potato arrived in Europe and it seemed as if the writing was on the wall for the humble parsnip. The potato quickly grew more popular than the parsnip and over the years it came to be neglected and was almost forgotten completely by some. But now the parsnip is back!

## Yellow flowers

Parsnips, like carrots are biennials. This means that they will flower in their second year but we tend to eat them all before they get to the flowering stage, so we seldom see their rather fabulous yellow flowers. The parsnip comes from the same family as hemlock, celery, parsley and caraway. The plant (not the root which we eat) is actually classified as harmful, and it can sting. Handling its shoots and leaves requires protective clothing because prolonged contact with the leaves can cause phytophotodermatitis, a condition in which skin becomes unusually sensitive to ultraviolet light, resulting in a serious irritation of the skin a little like sunburn.

But the root is a different story, luckily, and is stuffed with goodness. It is actually richer in vitamins and minerals than its close relative, the carrot. It is particularly rich in potassium, with 600 mg per 100g. The parsnip is also a good source of dietary fibre. Plus, they have a distinctive nutty-sweet taste and they're a doddle to grow. Do you still have a little space left in your garden? Why not plant some parsnips?

## Growing parsnips

As we mentioned, before the potato arrived in Europe, parsnips were widely used in cooking. Few vegetables are as easy to grow, as nutritious or as versatile and they are also available fresh throughout the winter, actually improving as the winter sets in, especially if frost gets to the roots.

Soil is the most important factor when growing parsnips. If you have thin gravelly soil, you will get small misshapen roots. The best soil is rich and slightly on the heavy side. It should not have been recently manured as this will cause the parsnip to fork. Almost any well drained soil will produce a good crop.

Parsnips dislike very acid soil and do best in one which is in the range of slightly acid, neutral or slightly alkaline. So test your soil with a soil test kit several weeks before preparing the seed bed and if necessary, add lime to achieve a pH of 6.5. The site you choose for your parsnips is not as important as the soil, they prefer an open sunny site, but they will also grow quite happily in a lightly shaded plot.

## Sowing the seeds with love

The traditional time to sow parsnip seed is late winter but, unless the winter is mild, the soil is often frozen hard or too wet at this time. In most years you will probably have to wait until early spring before you can sow. Although parsnips appreciate a long growing season, you can sow later, right up until late spring if you have to, and you will still get a worthwhile crop. Ensure that the seeds are fresh - parsnip seeds do not keep well.

Before sowing, make a shallow drill in the soil about 1 inch deep. If you are planting more than one row, make the rows 12-18 inches apart. Sow one seed every 2 inches. After the seeds have been sown cover them with soil, sifted soil is best for this, and then firm down. Water the area if the weather is dry. Germination takes approximately three to four weeks and it is quite possible for the newly forming seedlings to get lost among newly germinating weeds. Weed frequently and carefully.

## Harvesting parsnips

Your parsnips will be ready for harvest by mid-autumn, but to dig them up then would be a bit of a waste. The flavour is improved by exposure to frost because this increases the amount of sugar in the roots. Parsnips can be harvested up to mid-January.

Small parsnips in light soil can be pulled up once the soil around them has been loosened with a fork. But normally the only way that parsnips can be lifted without breaking them is by digging. Begin at the end of the row and dig a hole close to the last parsnip. Dig the hole as deep as the parsnip and then loosen the soil around the root. Then you can remove the parsnip easily without damaging it. You may find that you have to dig down much further than you expect, the end of a parsnip tapers off for a considerable length – 6 inches or more – and they are very firmly anchored into the soil.

## Tip: storing parsnips

Although the best-flavoured parsnips are ones that are lifted and taken into the kitchen straight from the ground, you can also store them in the same way as carrots. Do not store them in the fridge but pack them in layers of dry sand or peat in a large wooden box. Put a lid on the top to keep out the light and place the box in a cool, dry and well ventilated place. •



# RECIPE PARSNIP CHIPS

On the other hand, you might say 'Forget about storing them. I'll make chips out of them straight away.' We like that idea. So here's the recipe. Remember, it's important to slice these thinly and as evenly as you can.

- 1 lbs of parsnip
- 1 teaspoon fennel seeds, toasted and ground
- 1/2 teaspoon ground cumin
- 1/2 teaspoon chili powder
- 1/2 teaspoon paprika powder
- 1/2 teaspoon black pepper
- 2 tablespoons of high heat oil
- 1 teaspoon salt

**Preheat oven to 480°F.**

Mix the fennel, cumin, chili powder, paprika, and pepper in a small bowl and set aside.

Pat the parsnip slices with a paper towel and place them in a large bowl, drizzle with oil and sprinkle with the spice mixture. Season with salt to taste.

Place the parsnips in a single layer on baking sheets. Roast for 15-20 minutes, rotating the sheets from top to bottom half way through and flipping the chips over with a spatula. The baking time can vary depending on a lot of factors, so make sure you stay close to the oven and check that they are not burning. These taste great with a couple of friends and a funny movie.

E N J O Y !

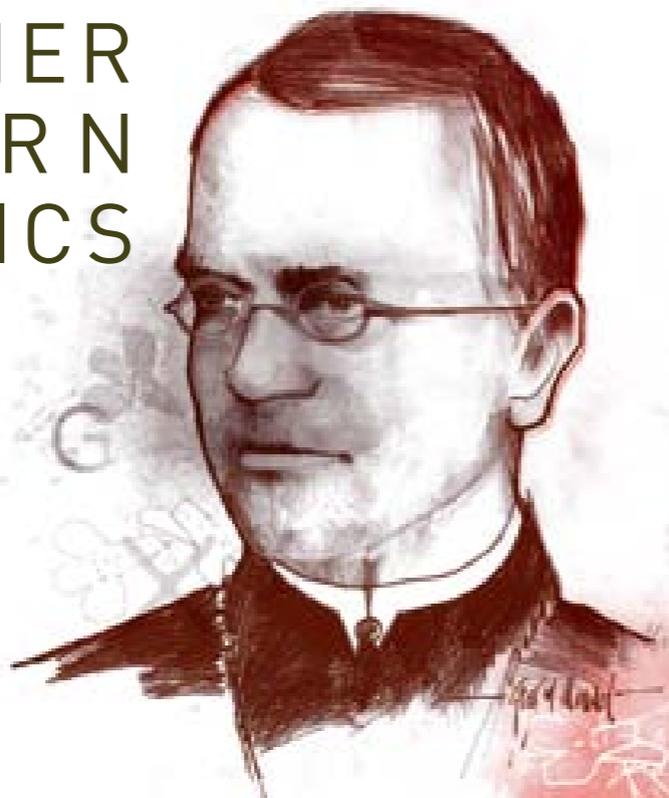




We could talk and write almost endlessly about the subject 'genetics and breeding'. That's exactly why we have chosen to devote a series of items to the subject. We begin in this issue with a general article about the rules of Mendel, which will give you the basic principles. In future editions, we are going to discuss pheno- and genotypes, day-neutral plants/flowering and how to protect genes.

# MENDEL

## THE FATHER OF MODERN GENETICS



Gregor Johann Mendel

GREGOR JOHANN MENDEL (1822-1884) WAS AN AUSTRIAN MONK WHO LIKED TO DABBLE IN BOTANY, BUT HE WAS NOT JUST ANY BOTANIST. BY STUDYING THE INHERITANCE OF PROPERTIES IN PEAS (PISUM SATIVUM), HE WAS THE FIRST BOTANIST TO DEVELOP A THEORY ABOUT HOW GENETICS WORKED. TODAY,

THIS IS SEEN AS THE FOUNDATION FOR ALL PLANT BREEDING. By Tanja Roovers, CANNA Research

Mendel was born in Heinzendorf (now Hyncice in the Czech Republic) in 1822, the son of a farmer. His father Anton used to experiment with growing the best fruit in his orchard and young Gregor spent a lot of his time there. But instead of taking over the farm, as he was expected to do, he went to

school. He obtained his gymnasium diploma in 1840 and he went to the Philosophical Institute in Olmütz (Olomouc). In 1843 he went to Brünn (Brno) to join the Augustinian St. Thomas monastery where he could study and not have to

worry about earning money. The motto of the monastery was 'Per scientiam ad sapientiam', which translates as 'Knowledge leads to wisdom'. That was exactly what Mendel was looking for. At the monastery he studied physics, mathematics, meteorology and botany and he could study in the library which contained over 20,000 books. When Mendel was 25 he became a priest but that was not how he wanted to spend his life. In 1850 he went to the University of Vienna where he met scientists like Christian Doppler (known for the Doppler effect) and Franz Unger (who documented the relationship between soil and plants). Franz Unger told Mendel about a breeding experiment involving pea plants (*Pisum sativum*). In 1853, when Mendel returned to Brünn, the abbot allowed him to grow his own pea plants in the greenhouse of the monastery to carry out research. Mendel's only other responsibility was occasionally teaching at the local school, so he was able to focus on his research with the pea plants.

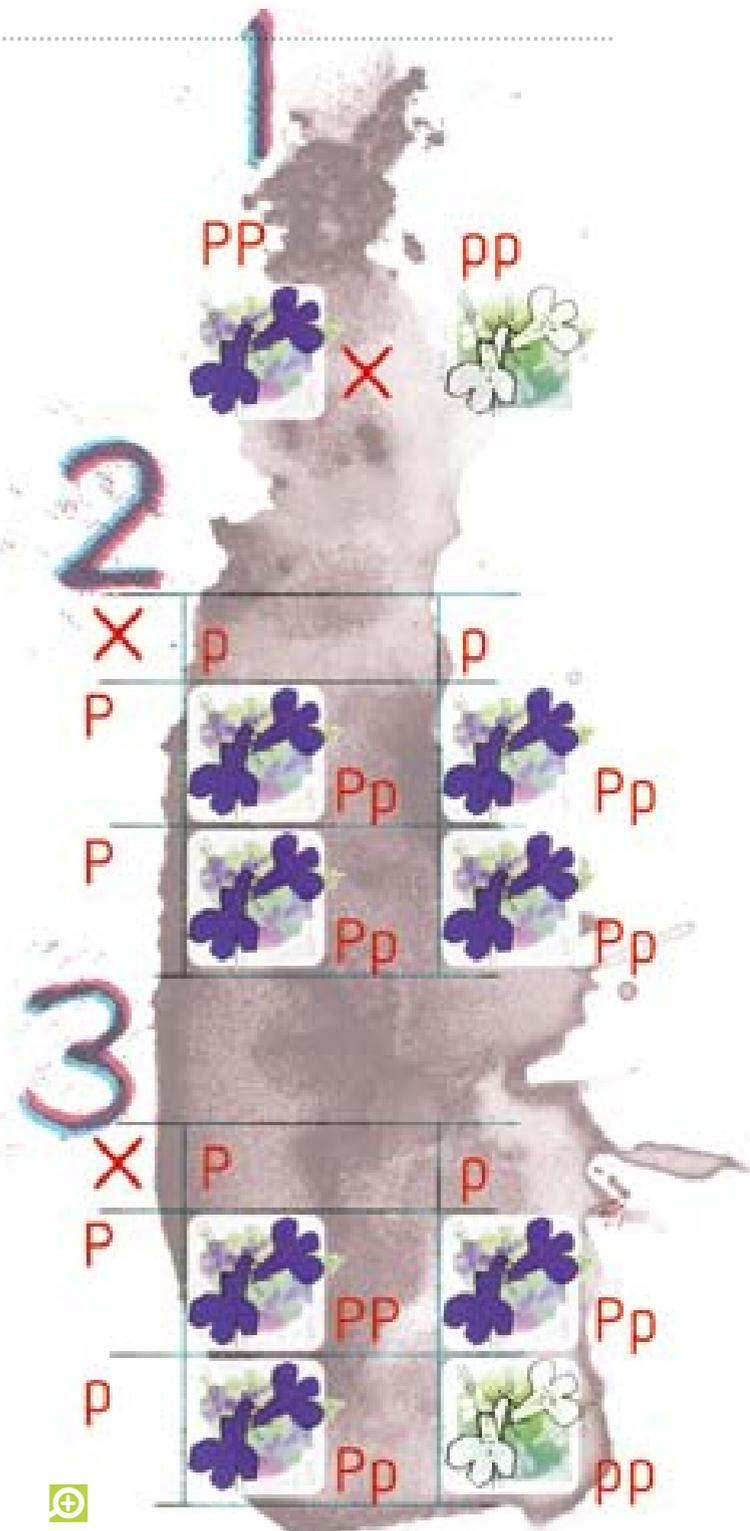
### Mendel's research

For many years, Mendel grew peas and kept precise records of them. In 1856 he had twenty-two pure-bred mother plants which would also propagate pure-bred plants, meaning that every successive generation looked exactly like the mother plants. The pea plant is monoecious, meaning that every flower has both male and female reproductive organs. Mendel removed the anthers from the stamen which contain the pollen and pollinated the pistils (female reproductive organs) with the pollen from other pea plants. He then covered the pistils to ensure they would not get damaged or pollinated by other plants. This way he had full control over his experiments. It is estimated that Mendel used 10,000 plants, 40,000 flowers and 300,000 peas in his experiments.

### Dominant and recessive genes

In his research Mendel focused on seven characteristics of the pea plants, each with only two possible expressions (two versions of every gene). The characteristics were: the form of the seeds (grey and round or white and wrinkled), the color of the cotyledon (green or yellow), the color of the flowers (white or violet), the shape of the pods (full or constricted), the color of the pods (green or yellow), the location of the pod on the stem (axial or terminal) and the length of the stem (short or long). A lot of plants, including peas, are diploid because they have two copies of every gene in every cell. When a diploid organism has two of the same gene versions it is called homozygote, and when the gene versions are different is known as heterozygote. In heterozygote organisms, one of the gene versions will determine the characteristic of that plant - i.e. one of the genes is dominant while the other, which does not show, is the recessive gene.

When both gene versions are equally dominant, this is called co-dominance and when the recessive gene version has some influence this is referred to as incomplete dominance. All the hereditary properties together, whether they are actually present or not, make up the



**Figure 5:** A Mendelian inheritance in a flower with a dominant (P, purple color) and a recessive property (p, white color).  
1. One parent plant is homozygous for the dominant flower property (PP), the other for the recessive property (pp).  
2. In the first generation (F1) all flowers are purple and they all have the same genotype: Pp.  
3. In the second generation (F2), formed after breeding plants from the first generation, 75% of the plants is purple and 25% is white, even though the purple plants 2/3rd are Pp and 1/3rd are PP.



Photo Courtesy to Heasley photography.

genotype of the organism. Through sexual reproduction, an organism gets one of every gene version from the two-gene versions of his parents, at random. It may end up with the dominant or the recessive gene. When both parents are heterozygote and both pass on the recessive gene version (a chance of 25%), the offspring will have a different characteristic from both parents. Because of this, some properties can skip a generation, only to reappear in the next.

After a lot of research Mendel came to the following conclusion: several pairs of contrasting properties can arise from a 'factor' (which was later called a gene) which has alternative forms. Each plant has one pair of these factors that determines a particular property, or one factor, of every parent plant.

**The three laws of Mendel**

Mendel formulated three laws. The first law is the law of segregation which states that if two pure-bred individuals differing only in one characteristic are bred, then the first-generation (F1) plants will be identical. This characteristic is still used today in plant breeding when large numbers of uniform plants need to be produced.

The second law is the law of dominance: breeding individuals from a uniform first generation (F1) will

**MENDEL**

**THE FATHER OF MODERN GENETICS**

result in plants with different genotypes, whereby the characteristics will differ in a fixed ratio. These are 3:1 in case of dominant-recessive inheritance (see Fig. 5) and 1:2:1 in case of partial or co-dominance (Fig. 6).

The third law is the law of independent assortment: the various characteristics are inherited independently of each other (if they are on different chromosomes).

In 1864 Mendel wrote his book 'Versucht über Pflanzenhybriden' (Experiments in plant hybridization), of which there are still 40 original copies. One was found in Charles Darwin's library, but that copy was never read as the pages were still together. In 1868, Mendel became abbot and this, combined with a storm that destroyed his greenhouse in 1870, marked the end of his research.

In 1884 Mendel passed away at the age of 62, but that was not the end of his work. In 1900 Karl Correns, Hugo de Vries and Erich von Tschermak discovered Mendel's work and used it as the starting point for new research into genetics. By that time some people thought that Mendel had falsified his results because they were so accurate, but the correctness of Mendel's work can be put down to the number of repetitions. Mendel was fortunate in that he had chosen seven properties of the pea plant that were on different seven chromosomes, so there was no coupling of hereditary characteristics. Mendel's work finally got the attention it deserved and Mendel became known as 'the father of genetics'.



Photo Courtesy to Darwin Cruz.

Figure 6: This Rhododendron shows co-dominance; both the gene variations for pink and for white are expressed in this two colored flower.



**What's HAPPENING**

There was a time when a hotel was just a hotel. A bed. A shower. No more no less. But happily, those days are gone! Take a good look at these quirky, astonishing or magical hotels. But be warned... the travel bug is likely to give you a hard bite after reading. Enjoy your trip! By Marco Barneveld, www.braindrain.nu



**10 Remarkable getaways**

**IT'S NOT A DREAM, IT'S A HOTEL!**



**Palacio de Sal, Bolivia**

A hotel made entirely of salt. How cool is that? Palacio de Sal (which is Spanish for Palace of Salt) is built completely of the stuff. You can find this salty treasure about 217 miles south of Bolivia's capital La Paz in the Salar de Uyuni, the world's largest salt flat. It is located near the crest of the Andes at an altitude of 11,994 feet. Salar de Uyuni has long attracted tourists, who came great distances and needed a place to rest before returning to the city. Of course, such a resting place needed to be built of something, and conventional building materials are in short supply in the area. So it was decided to construct a hotel made of salt, one thing they have plenty of in Salar de Uyuni.

The building is constructed from about 1 million salt blocks measuring about 14 inches each, which are used for the floor, the walls, the ceiling and even the furniture, including beds, tables, chairs and sculptures.

Be warned though, licking the walls is strictly prohibited as this would cause degradation. We guess that slapping

your steak against the wall in order to season it up would probably be prohibited too.

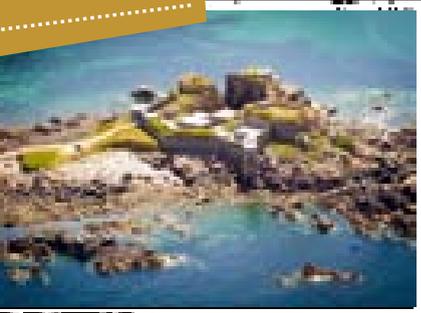
Price: \$105,- [www.palaciodesal.com.bo](http://www.palaciodesal.com.bo)

**Woodlyn Park, New Zealand**

Have you ever wanted to sleep in a train, plane or boat? In Woodlyn Park you can do all of this at once. Join Billy Black and his team at their famous Woodlyn Park location to experience traditional New Zealand crafts and shows in these amazing properties. What about a 1950s Bristol Freighter Plane fully transformed into two beautiful self-contained motel units. This plane was one of the last allied planes out of Vietnam and is the only accommodation of its type in the world. Or the Waitomo Express, a 1918 Rail Carriage beautifully refurbished into a completely self-contained motel unit. They have even had an old army boat refurbished into a gorgeous hotel. Let the good times roll!

Price: \$130,- [www.woodlynpark.co.nz](http://www.woodlynpark.co.nz)





### Fort Clonque, Alderney

Fancy spending a few nights in a gorgeous 19th Century fortified harbour defence in the Channel Islands? We do! Fort Clonque, the most remarkable of the great harbour works of Alderney, occupies a group of large rocks off the steep south-western tip of the island, commanding the passage between it and the small island of Burhou. The property is reached by a causeway leading to a drawbridge entrance and was originally designed for ten

3

64-pounder guns in four open batteries, manned by two officers and 50 men. On calm days the sea can be heard all round the Clonque, washing restlessly over the rocks; and on rough days it is comforting to reflect that the wall of the East Flank Battery is 19 feet thick. Stormy weather is no stranger at this location, and during some high tides the fort is cut off as the sea rises up between it and the mainland. We love this hotel the best in heavy stormy weather. Probably the coolest spot at Fort Clonque is the old emplacement of a gun so large that it now makes a handsome bedroom looking towards Guernsey. It is run by The Landmark Trust, which has historical buildings all over the UK that you can stay in.

Price: \$260- [www.landmarktrust.org.uk](http://www.landmarktrust.org.uk)

## IT'S NOT A DREAM, IT'S A HOTEL!

### Nature Observatorio, Costa Rica

Some hotels are like dreams that have come true, like this tropical forest tree house overlooking the Caribbean Sea. Problem is, you'll never want to leave. Imagine a two-story tree house, with modern conveniences and comforts, powered by solar energy and using collected rainwater, suspended 82 feet in the rainforest canopy. The first level of this tree villa has a 360° view over the jungle and the Caribbean Sea, with hammocks and sofas. Not a single nail or screw was used to secure the structure, which is held in place with strong nylon webbing. Built from the top down, it has two double bedrooms while a hatch in the top room provides access to the very top of the tree Observatorio, a further 98 feet above you.

Don't worry about having to climb up there yourself, though. The solar collectors also power an electric winch if you would rather not pull yourself up. This is how it feels to be a tree monkey.

Price: \$144,- [www.natureobservatorio.com](http://www.natureobservatorio.com)

5



### Utter Inn, Sweden

Imagine a room floating underwater in a Swedish lake near Stockholm, where you sleep in an underwater aquarium. The Utter Inn is the brainchild of Mikael Genberg, a local artist and sculptor who has chosen to focus on "making art for the public". The hotel's only room is 9 feet below the surface of Lake Mälaren in Västerås, Sweden and contains only twin beds and a table.

The Utter Inn is based on the typical Swedish dreams of a small red house with white gables on its own island. On top of that you can spend your night 9 feet underwater with panoramic windows in all directions.

It is a remarkable feeling, going to bed while the fish swim past, watching you curiously. You are in an aquarium – but this time it's you that's being watched by the fish.

Price: \$228,- [www.mikaelgenberg.com](http://www.mikaelgenberg.com)

### Lifeboat Hotel, the Netherlands

Ah, the Dutch, perpetually struggling with all that water that surrounds them. They recently discovered that a Watson class lifeboat can be lovingly restored into a wonderful floating hotel. In fact, this is the third of a trio of unusual hotels in Harlingen and it is located next to a lighthouse and a harbour crane. The Lilla Marras lifeboat saw decades of active service and was involved in 105 daring sea rescues between 1955 and 1979 along the English coast, saving 45 lives.

Lovingly restored by the same Harlingen team that brought the harbour crane hotel and the lighthouse back to life, the Lilla Marras is indeed a work of art. The traditional lines of an ocean workhorse might suggest a Spartan interior. However, intelligent design and professional craftsmanship have created an overnight home equal to the most luxurious designer properties. Sweet dreams.

Price: \$299,- [www.vuurtoren-harlingen.nl](http://www.vuurtoren-harlingen.nl)



### Jules Undersea Lodge, USA

When you visit Jules' Undersea Lodge in Key Largo, Florida, you'll discover that the name is no marketing gimmick. Just to enter the Lodge, you'll need to get your SCUBA gear on and dive 19 feet beneath the surface of the sea. Entering through an opening in the bottom of the habitat, the feeling is much like discovering a secret underwater clubhouse.

Jules' Undersea Lodge started out as the La Chalupa underwater research laboratory in the 1970s, and was one of the most advanced research habitats created.

The main feature of each room is the large, round windows that look out into the sea. The mangrove lagoon that Jules is located in is a natural nursery area for many reef fish. Tropical angelfish, parrotfish, barracuda and snappers peek in the windows of the habitat, while anemones, sponges, oysters and feather-duster worms seem to cover every inch of this underwater world.

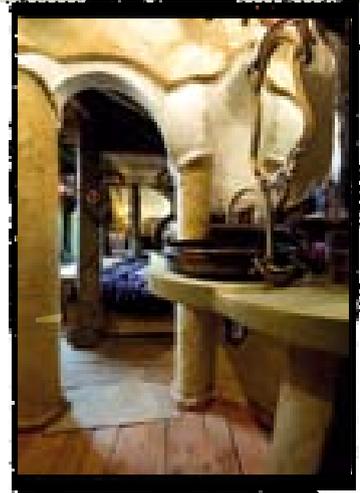
Price: \$522,- [www.jul.com](http://www.jul.com)

### La Balade des Gnomes, Belgium

So you like fairy tales? You enjoy playing Warcraft and loved the houses of the Hobbit's? Well then this is the place for you. Picture amazing fairy-tale rooms and a Trojan Horse suite. These ten extraordinarily decorated and furnished bedrooms draw their inspiration from the four corners of the world, re-interpreted as fairy tales.

Hidden in an unassuming farmhouse up a pleasant – but not particularly noteworthy – country lane, this amazing property was designed and built by architect and visionary hotelier Mr. Noël. Originally opening an innovative restaurant, La Gargouille (the Gargoyle) specializing in delicious dishes using local ingredients and organic produce, he has taken his inspiration from fairy tales to design these amazing bedrooms, next door to the restaurant. Defying normal classification, these rooms demonstrate incredible imagination, attention to detail and sheer audacity that will delight you.

Price: \$189,- [www.labaladedesgnomes.be](http://www.labaladedesgnomes.be)

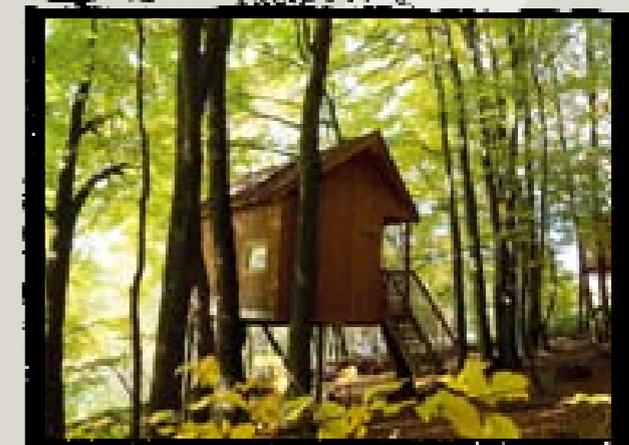


### Baumhaus Hotel, Germany

Children's dreams come true! Living in your own real-life tree house. At the Baumhaus Hotel in Germany you can choose from five cosy tree houses that are from 26 to 32 feet up in a tree in a fantastic recreational park outside Görlitz.

These two-storey dwellings are furnished in a quirky rustic style, with brightly coloured walls and off-angle windows. Odd-shaped beds are quite normal since you won't find any straight walls. But after you have spent an evening in the bar which serves a range of Germany's delightful beers, that will not matter anyway. To recover from your night at the bar you can take a shower with a metal grid floor, so that you can see the ground 32 feet below you. That will wake you up. Release your inner child. Rent a tree house!

Price: \$326,- [www.baumhaushotel-solling.de](http://www.baumhaushotel-solling.de)



### Kakslauttanan Hotel and Igloo Village, Finland

The problem with ordinary igloos is that you can't see the sky. There is no such problem with the glass igloos built for watching Northern Lights in comfort. At Kakslauttanan they have both snow igloos and glass igloos for you to choose from. It is also the home to the World's Largest Snow Restaurant, and you can enjoy all of Lapland's other winter activities including the Northern Lights (Aurora borealis), which are generally visible from late August to late April. You can take a ride on a sled pulled by dogs or take an axe and go ice-climbing. But when you travel to a place as remote as this, it is the tranquillity that is the best reward. Surrounded by Lapland's exotic and stunning scenery, you can sample the peace and quiet of sleeping in the snowfields. And all that snow makes such a good sound insulator that this must be one of the most peaceful places on earth. Imagine yourself lying on your back watching the black sky twinkling with northern stars. Wish you were there? We do.

Price: \$250,- [www.kakslauttanan.fi/en](http://www.kakslauttanan.fi/en)





## DAMSELFLY DID YOU KNOW THAT....?

- These pretty eyes belong to a damselfly, which is not to be mistaken with a dragonfly. How can you distinguish them? The eyes of a damselfly are placed at the sides of its head, while a dragonfly has eyes which touch each other above the head.
- The eyes of a damselfly consist of about 12,000 tiny facets (a dragonfly has about 50,000 facets). They need the upper part to see

things in the distance. The lower part makes sure that the insect doesn't miss anything – such as prey – close by. The antennae are there to measure speed or smell any appetizing passers-by.

- Damselflies are organic pest controllers because they eat flies and mosquitos. Adult damselflies catch their prey in the air while flying. Damselfly larvae spend life under the water surface hunting

on mosquito larvae and other aquatic organisms.

- It is simple to attract these organic pest controllers into your garden. Just establish a pond and add water plants like hornwort, starwort and pondweed. The damselflies will stick around if they like it.
- Damselflies are an indication of good water quality and biodiversity in natural area. The more variation, the more damselfly species

will appear. Damselflies are a measure of good environmental management.

- Damselflies have existed for over three-hundred million years. The biggest ones had a wing span of 2,4 feet! Today, the biggest damselfly is the *Megaloprepus caerulatus* which lives in Middle and South America. This one has a wing span of 7,5 inches.



# Pests & DISEASES

Compared to other pests, pathogenic micro-organisms in the soil are silent killers that cannot be seen and are very difficult to eradicate once they are established. One of these micro-organisms is *Pythium* spp.

By Iñaki Garcia, CANNA Research



## PYTHIUM AND ITS EFFECT ON CROPS

### What is Pythium?

While it has been considered a fungus, it is actually more closely related to algae, protozoa or some types of mould. In fact, the term *Pythium* refers to a wide group of species, many of which are pathogenic for plants, causing root rot or rotting at the base of the stem.

Like fungi, *Pythium* species reproduce through spores. In favourable conditions, these spores germinate on plant roots where they begin to grow by extending their mycelium all over the plant. *Pythium* produces two types of spores: zoospore and oospore.

Zoospores are asexual spores produced by a single individual. One of the main characteristics of these zoospores is that they can swim in the water thanks to two little hairs called flagella, which they use like oars. This means that *Pythium* can spread rapidly, especially in recirculating hydroponic systems where plants share the same nutrient solution.

Oospores are sexual spores that have with a new combination of genes. They are formed at the end of the host plant's life. In contrast to the zoospores they do not have flagella, but they are highly resistant to adverse



Figure 7: Roots infected by *pythium* turn brown in color.

Figure 8: *Pythium* can infect the base of the stem, blocking the supply of nutrients.



Figure 9: In cuttings, *pythium* can get into open wounds and infect the plant tissue.

*Pythium* zoospores will swim to the root tips following root exudates. Once they reach the root surface, the spore will line up in such a way that it can grow directly into the root surface. A damaged root is easier to penetrate and as these leak more exudates, the spores will target any damaged areas. They will also appear when roots start to rot, or when cuttings are planted. Gnats can also help *Pythium* to enter into the plant as they create small wounds when they feed on plant roots.

In an unbalanced situation, such as when there are large fluctuations in moisture, temperature and oxygen, plants will expend much more energy on producing and again let die its roots. This makes a plant more vulnerable to *Pythium* than a plant in a more stable environment.

### Damping off

*Pythium* can infect seeds even before they germinate. Since it is quite difficult to spot the symptoms with the naked eye, growers tend to think that something was wrong with the seeds rather than that a pathogen was present.

Germinating seeds and young plants also are very susceptible to *Pythium*, as the root tips are still soft and therefore easier to penetrate. When this occurs, the tip of the radicle turns brown and stops growing. In the case of very young plants, *Pythium* will block of the vessels at the base of the stem, causing the plant to droop and ultimately die. This is known as "damping off." Other micro-organisms can provoke similar symptoms, such as *phytophthora*, *fusarium* and *verticillium*, but only a dedicated laboratory can determine precisely which micro-organism is the cause of an infection.

To prevent damping off, it is very important to plant in a well-aerated place and to use seed substrate that has been disinfected and produced so that it does not contain this type of hazardous micro-organism.

In general, it is essential to use drinking water for germination, such as bottled water or water from the tap, and to avoid using water from air conditioners, wells or rain since this could contain the spores of these pathogens. Certain precautions must also be taken when taking cuttings. All equipment and work surfaces need to be decontaminated, since *Pythium* can easily attack recently planted cuttings through an open wound. This is why some hormonal rooting powder contains fungicides to avoid this type of problem.

### Root rot in hydroponic systems

Hydroponic systems are an ideal breeding ground for this type of disease, especially recirculating systems. Symptoms in infected adult plants include arrested growth, dwarfism and very closely spaced nodes. Leaves will show symptoms of deficiency while root systems are viscous and denuded. There is also an intense and characteristic smell.

This is why it is absolutely essential to use hydroponic cultivation systems that prevent the development of these pest by using, for example, ozone-treated water, water disinfected with ultra-violet light, bio-filters, applied cellulose enzymes and/or phosphonates. •



# Questions & Answers

We receive a lot of questions about growing. Of course, our researchers are more than willing to answer them! Go to the contact page on our website [www.canna-hydroponics.com](http://www.canna-hydroponics.com).

## Question

Hope you can help. My plants grow too slow. Its good in my veg room, they grow fine. When I moved them to the flower room they slow right down and turn into a lighter and duller green and develop in a lanky fashion. The climate is perfect I have triple checked. When I move the plants back on the growing table they mysteriously recover within a week. Same climate, same care. I don't know where to go from here! Please help me.

## Answer

Assuming you are monitoring the environment and watering your plants properly, the next step lies in figuring out why your flower room is braking your growth rate. Here are some extra leads you can investigate that may help you figure out what in the environment is different between rooms.

1. Are there any new building materials and/or paint in the flower room? Some stuff releases volatile organic compounds over a short period and can easily disorder growth patterns. Everything that is different is suspicious as even cheap plastic can breakdown in light to off-gas toxic compounds.
2. Have you checked the soil temperature in both rooms? Anything under 64°F is definitely part of the problem. Containers sitting on unheated cement floor often cool down excessively through thermal conduction.
3. Any plant shock such as caused by transplation, extreme climate, high lighting intensity, or change in watering strategy could aggravate the room switch. Hope it helps!

## Question

Hi, I'm a great fan of your products and more so with Bioboost. I have been dealing with some active invaders. They are mini black flies flying around. When I water my plants I see tons of silvery miniature worms rise to the surface. Should I worry?



Photo Courtesy D. Heleba and C. Armstrong

## Answer

Well it sounds like your garden is host to fungus gnats but the only way to know for sure is to properly identify the little bugger. Here are a few links to help you do that.

- [www.insectid.ento.vt.edu/insect-id/vegetable-pests/index.html](http://www.insectid.ento.vt.edu/insect-id/vegetable-pests/index.html)
- [www.earthlife.net/insects/orders-key.html](http://www.earthlife.net/insects/orders-key.html)
- [www.koppert.com/pests](http://www.koppert.com/pests)

If you confirm it is fungus gnats then know that they feed on dead root fungi. Roots die usually as a result of improper watering or poor soil chemistry such as high salts. Correcting the root dying issue usually scales back the fungus gnat population. Even more important, if populations are high, then you may very well be over-watering, even slightly will boost the numbers. Correct moisture levels should hold populations down to manageable levels. If you grow organically then you should get used to their presence as they are part of the natural decomposition process which happens in normal organic soils.

## Question

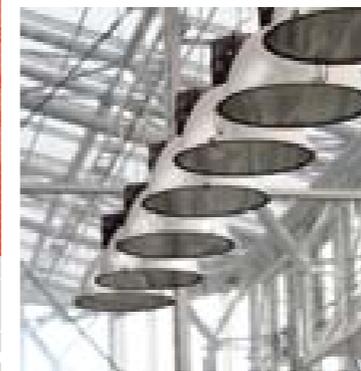
I have 600w ballasts that can be operated either on 120V or 240V, would I save electricity by operating them on 240v? Is there a way to evaluate how much it will cost to operate them?

## Answer

The easy answer is no. Even though the ballast may be slightly more efficient when run at higher voltage, the difference is minimal. The electrical companies charge you for watts used. Usually this is billed in kilo watts per hour (kW/H). Your bulbs will use 600 watts on 120 or on 240, and you will be charged accordingly. If your electrical company charges 0.10\$ per kW/H, each 600w bulb will cost 6 cents per hour. Then it is just a matter of making the maths based on how many hours per day the lights are on and you will know your daily electricity cost.

## Question

How far away can I extend my lamp cord from my ballast?



## Answer

There is no official answer to this, as most ballasts are designed to have the bulb under 16 feet away from them, it is much wiser to use them as they are manufactured. Recent innovations in electronic ballasts have extended this limit to over 48 feet, but that needs to be verified with the manufacturer of the ballast as there is a wide difference in specification and quality between E-Ballasts. The important fact to respect when extending the lamp cord is respecting the gage (diameter) of the wire often marked as 'AWG', the longer you go away the more the voltage drops, bigger wires have less drops than smaller gaged wires. As electricity is dictated by the Ohm law, with an equal resistance (from the light bulb) when the Voltage goes down, the amps will increase. This can create overheating and operation of components over their normal specs, thus possibly generating early failures or fires. Therefore the further away you go, the bigger the gage should be. One last thing, wire gage numbers are misleading, higher numbers are smaller than smaller numbers. i.e. 18AWG is smaller then 14 AWG.

## Question

I grow in an ebb and flow garden and am happy with the results. I have recently noticed that a slimy substance is covering the walls of the reservoir. It is translucent and only appears after four days from the main tank change. Nothing a good cleaning cant get rid off! Still I wonder if it can affect my plants?

## Answer

This slimy substance is usually a byproduct of a bacterial fauna living in your reservoir. If your plants are thriving and you regularly sanitize the equipment it most likely will never affect your crop. If you want to reduce the onset of this situation, here are a few tips:

- Reduce or eliminate air injection stones and apparatus in tank. The added oxygenation promotes bacterial development and skews the pH.
- Reduce or eliminate protein based organic additives such as fish emulsion or blood meal.
- Discontinue use of compost teas or microbial inoculants.
- Keep water temperature under 75°F.



## Question

I grow organic cucumber in 23 L containers. The vines are tied to a vertical trellis. I use a locally reputed organic soil mix and amend it with vermi-compost and good quality guano. The plants grow extremely fast and lush. The problem is that they are also host to some mildew fungi (downy or powdery mildew I believe). Once the leaves are affected, the fruits don't develop normally and some develop rot. I grow a large variety of organic plants in that area and never have issues with that disease. I do not spray anything on the foliage. Any ideas?

## Answer

One cause comes to mind. Adding guano and vermi-compost into the soil mix can introduce a high level of nitrogen in the form of ammonium. Ammonium will definitely boost growth and green up a plant. It also reduces the plant capacity to withstand fungal and insect attacks. High ammonium nutrition can also interfere with proper flowering and fruit formation. Guano is reputedly very rich in rapidly released ammonium nitrogen. Try cutting the concentration down or taking that ingredient out of the soil mix. Also, ensuring that the foliage is dry going into night, avoiding overhead irrigation, and looking at other varieties might also help.

## Question

I'm a long time user of the Coco line, recently I went to buy some PK 13/14 and realized that the N-P-K on the label used to be different in the past. All bottles at my local shop had 0-10-11 on them. The one I have home clearly says 0-13-14. There has seemed to be no changes on the labels recommended dose or on the feed schedule, even the nutrient calculator on your website does not seem to reflect any change in dosage. I've always had awesome results at the previous concentration, should I increase the dose now that it is 0-10-11, if so by how much?

## Answer

Thank you for your question and your long time usage of CANNA COCO! Be reassured, PK 13/14 has not changed a bit and is certainly not less concentrated then what is always was. The N-P-K figures that you now see on the bottles are the result of implementing North American rules in regards to N-P-K representations. These regulations vary from country to country. Therefore many will never see anything but 0-13-14 while others will see 0-10-11. The concentration of minerals used to be calculated by volume (0-13-14) but North America requires it by weight (0-10-11). While the amounts of minerals in the formula do not change, their representation does. In the end, do not worry, the product did not change so keep on using it the same way at 15ml/10L or 6ml/US gal, for 7 to 10 days in mid bloom/fruiting stage.



# Don & Nicky

(PART 1)

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 ("It's heaven on earth") in this, and three forthcoming editions.

## In Search of THE GOOD LIFE

"There are two paths to a life of freedom," an old man at a harbour in British Columbia once informed me. "The first is to make as much money as you could possibly require to live. The second is to live in such a way that you require as little money as possible."

The old man's aphorism held its quaint linguistic Yin-Yang appeal for a moment as if promising to reveal a deeper wisdom –if only I thought about his words for long enough. But the setting distracted me, not least a 38-foot sailboat that he and his wife called home for eight months of the year. I wondered how this boat had come into their lives.

I was invited on board and we went down below. The couple spent an hour describing countless summers meandering up and down the islands of the Salish Sea. I listened to their stories, entranced by the couple's enduring vitality. They projected a deep, genuine contentment with life imbued with an independent, timeless security –something I longed for. I left the harbour very impressed. I found it deeply inspiring to meet individuals like these. Inspired by their apparent lack of existential angst, I determined that I too would pursue this 'hybrid' path of freedom.

A few weeks later, after being deeply shocked by the price of second-hand sailboats, I lost my job. Along with my salary I was stripped of my Canadian work visa. My wife and I

headed back to Britain. We were excited because we knew we wouldn't stay very long. We acquired an old Subaru and an even older caravan (our 'sailboat on wheels') and headed south.

Caravanning affords you plenty of time to think and since my early teens I've laboured under the belief that some sort of global catastrophe is imminent. I remember being about fifteen years old and warning my friends that we probably wouldn't live to see the year 2000. That came and went without too much fuss. Now, I'm well aware that you're probably reading this in 2013 –or beyond. So, the sky didn't fall down. I'm sure that came as quite a relief didn't it?

However, just theoretically speaking, if there's a place to be when the brown stuff hits the air circulator, I reckon it's got to be France –specifically French Catalonia. In this beautifully warm climate, numerous rivers flow from the Pyrénées throughout the region bringing fresh, mountain water into hundreds of little towns, each with their own built-in irrigation systems, wetting the silt-rich soils of countless kitchen gardens. It's heaven on earth.

The gardens of French Catalonia are faithfully tended by an



1

Marmade is the tomato of choice in these parts. In fact, it's the only variety to be seen—until I turned up on the Catalan gardening scene!

2

Early May. Catalan gardens use trenches to channel the mountain water that flows through the town once or twice a week.

3

Subaru + Caravan = Thirsty! Our "sailboat with wheels" did not, regrettably, run on wind-power alone.



army of old folk. One guy in particular, Monsieur Bonnet, took a liking to me. He was well into his nineties and rabbit on incomprehensively in Catalan. I used thumb gestures to compliment him on his veggie garden. It was immaculate and in full swing.

Then, just a few days later, we received amazing news. My wife was pregnant with our first child! My worries were replaced with a new sense of optimism. We would join these old Catalonians and plant our own veggies right along side them – watching, learning, growing and eating from the land – roll on 2013!

*"Finally I was doing exactly what I wanted to do with my life: growing"*

There were a few derelict, overgrown plots apparently going spare. Did anyone own these? Would they mind if they were cultivated? To answer these questions I fashioned a WANTED ad and circulated it around local boulangeries. "Permettez-moi de planter votre jardin. Je fais le travail. Nous partageons les produits." (That's how Google

translated: "Permit me to plant your garden. I do the work. We share the produce.")

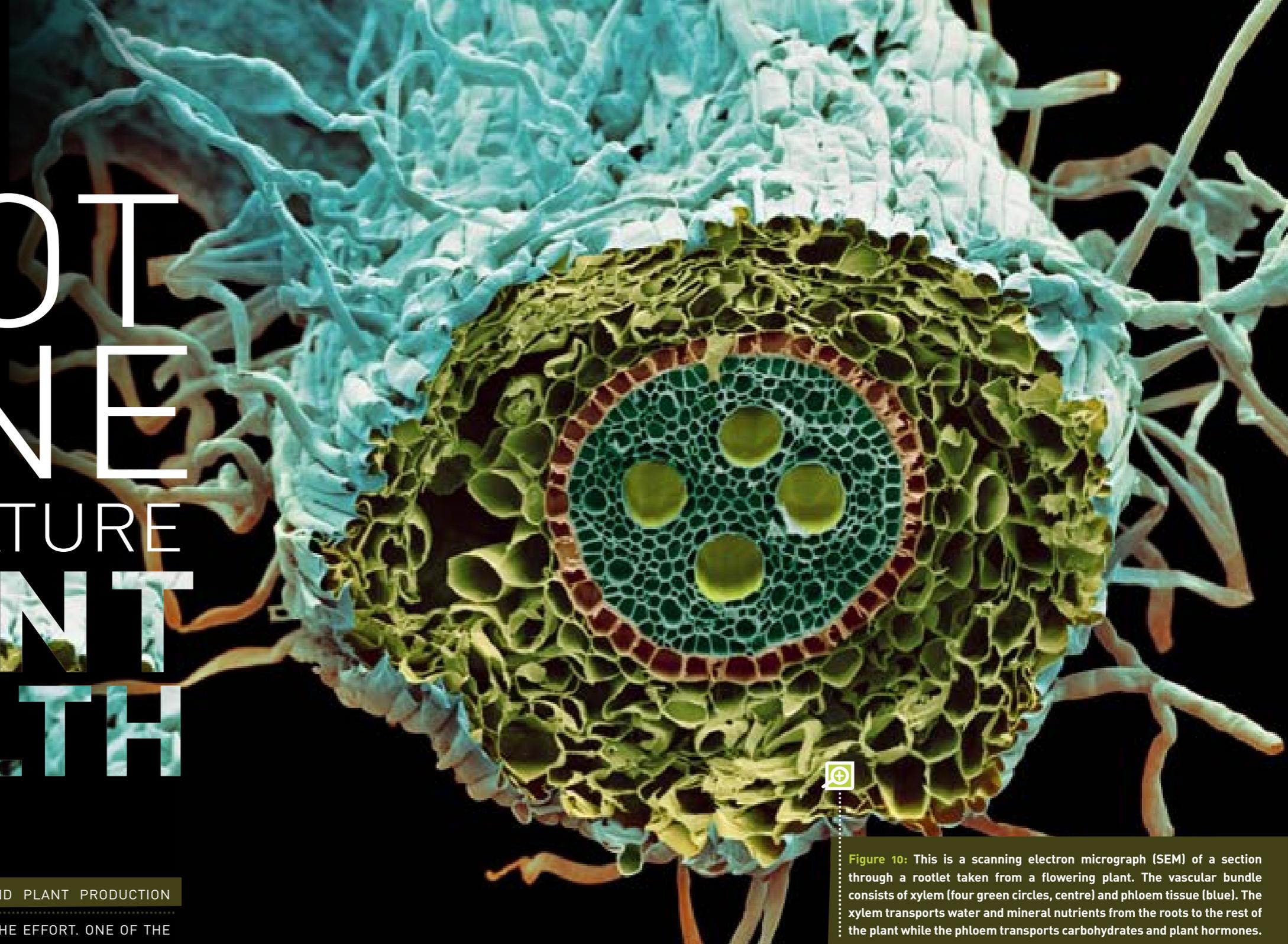
It worked! We received several offers –and they didn't even want to split the produce. One quarter-acre parcel was available right next to my garden mentor Monsieur Bonnet. The old folks even donated me their spare tools.

We found a caravan pitch and I focussed on the garden. I soon learnt to start work early. Afternoons were already too hot. But by early May I had my lettuce sown and dozens of tomato and pepper varieties on the go. Sure –I was far from 'self sufficient' but I felt as if I was on the path at last. In all that digging, an ancient peace began to suffuse through me. Finally I was doing exactly what I wanted to do with my life: growing! I had no idea that my lettuce would bolt almost immediately in the heat, that my mollycoddled tomatoes would wither days after transplanting, that my corn would starve in the nice-looking but thoroughly depleted soils or that my peppers would soon meet their Nemesis –the Tramontane! And to think that I'd even mused that the 'path' and destination were one and the same thing! •





# ROOT ZONE TEMPERATURE AND PLANT HEALTH



**Figure 10:** This is a scanning electron micrograph (SEM) of a section through a rootlet taken from a flowering plant. The vascular bundle consists of xylem (four green circles, centre) and phloem tissue (blue). The xylem transports water and mineral nutrients from the roots to the rest of the plant while the phloem transports carbohydrates and plant hormones.

THERE ARE MANY ASPECTS OF CROP AND PLANT PRODUCTION THAT ARE CRITICAL FOR THE SUCCESS OF THE EFFORT. ONE OF THE

MOST OFTEN OVERLOOKED AND SELDOM ALLOWED FOR ASPECTS OF PRODUCTION CENTERS AROUND THE TEMPERATURE OF THE ROOT ZONE. AFTER ALL, IT IS OUT OF SIGHT AND THERE IS NOT MUCH THAT CAN BE DONE ABOUT IT. BESIDES, IT MUST BE OK TO HOLD THE ENTIRE PLANT AT THE SAME TEMPERATURE, RIGHT? WRONG; AND HERE IS WHY.

By Geary Coogler, BSc Horticulture

## The temperature story

To begin, there are two main parts of a plant, the roots and the shoots, and one main intersection known as the crown. While composed of similar material, components, and engineering, the roles of the roots and shoots is, basically, opposite. The crown serves as the switching center that facilitates the change in function. The chemistry fundamentals are universal. While our focus here is in the root zone, the other two parts are affected as well. The basic purpose of a root is to take in water and those elements the plant needs to function that are available

in the root zone. Other purposes include anchorage/support and storage, which may be more important functions than uptake in some plants. Roots take in water and some nutrients through the basic process of osmosis where water moves across a membrane into the cells of the plant because of differences in their respective ion concentrations. Most elements other than water are most often actively pumped into the plant cells requiring energy. The root has to guard itself against too much of some things coming in and against the loss of what is inside. To do so, it has evolved protections,



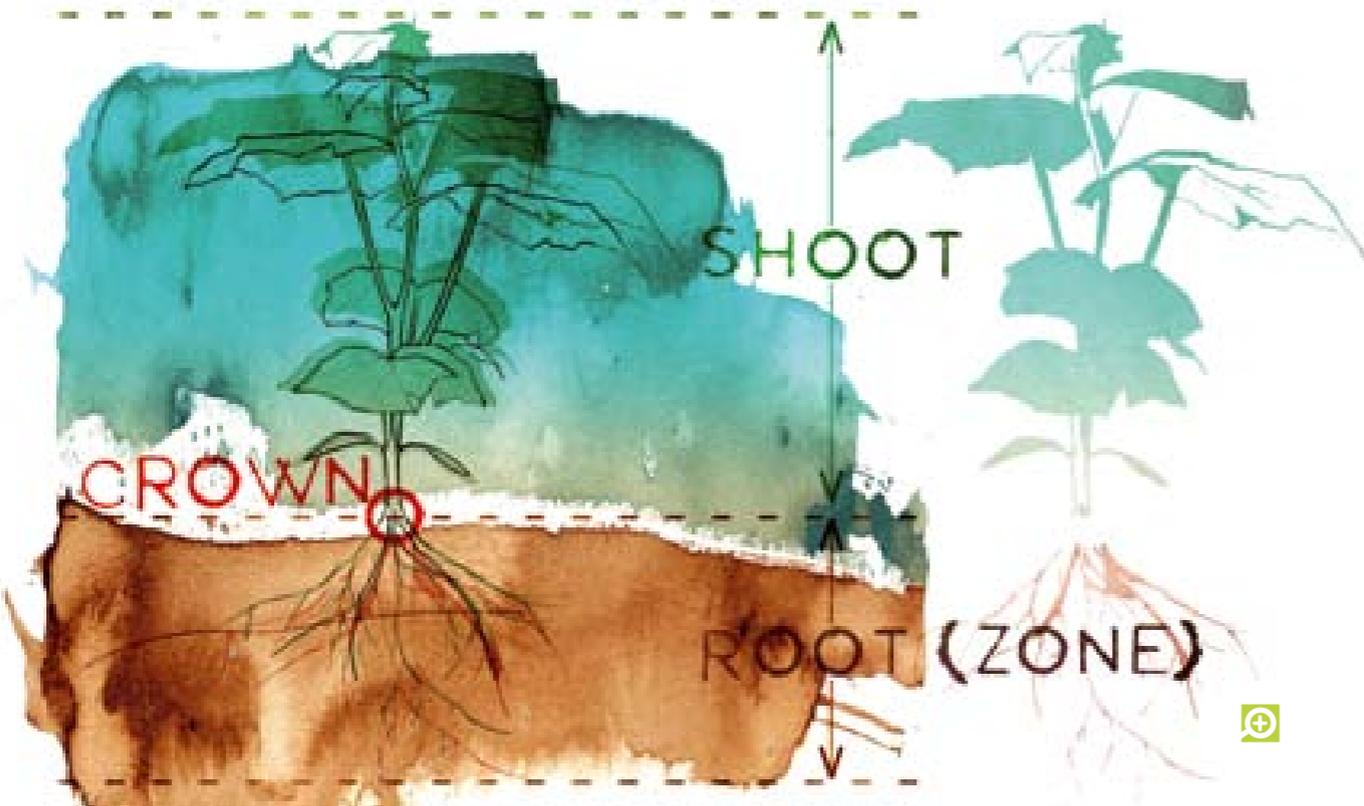


barriers, and infrastructure that match the need. The root does not harvest the power of light being, in fact, a large consumer of those components and energy derived from the sun. In doing so it must respire, take in oxygen (O<sub>2</sub>), and use it to reduce the carbohydrates made in the photosynthesis process in other areas of the plant, to release the energy for use in its processes. It has no requirement for carbon dioxide (CO<sub>2</sub>). Roots or shoots, chemical reactions inside the cells of the plant tissue give off heat. They also require a certain level of temperature to start and continue; when these temperatures get too high, the reactions go haywire. Roots take in water and they do their best not to give it up and as such do not transpire to cool the tissue but instead transfer the excess heat generated in these reactions (latent heat) to the surrounding medium. Dense mediums such as soil, sand, even water, have a large temperature buffer that make the 24 hour swing in temperatures a root will see very minimal under natural conditions.

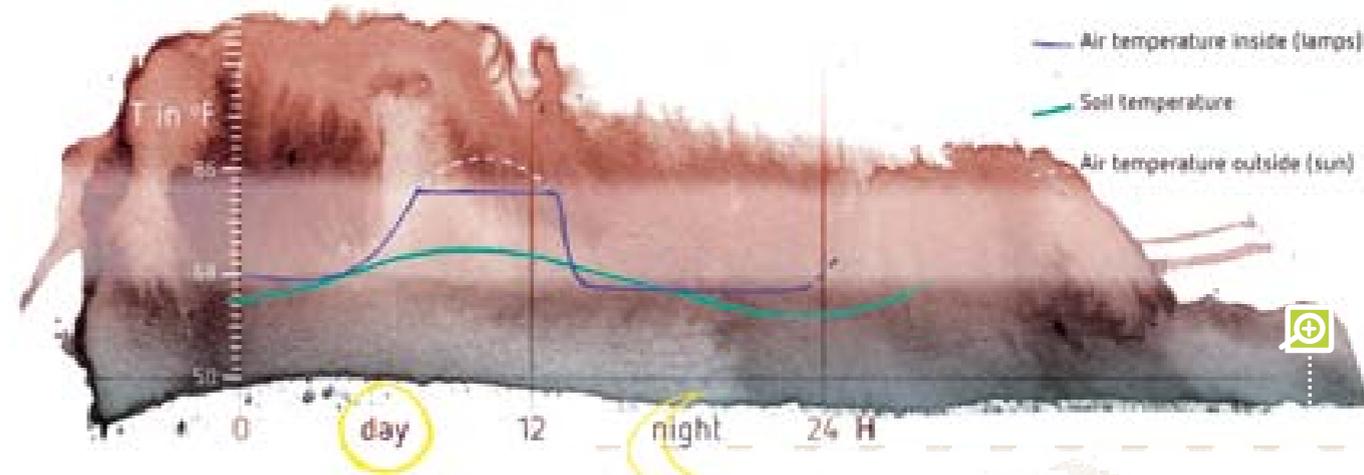
The basic purpose of the top is to produce energy from the sun and fruiting structures to pass on its genes. In the process, it provides energy products and complex building blocks known as carbohydrates to the root system so that it can continue to function and develop to match the demands of the top. The tissues are designed to allow water and elements to move as quickly as possible through the tissue of the plant to each and every cell of

# ROOT ZONE TEMPERATURE AND PLANT HEALTH

the plant. Complex systems, (transpiration) simple in the basic idea and wonderfully complex in design, evolved to move raw materials and finished products, provide a ridged support to the structure of the tissue, and facilitate the collection of solar energy and the conversion of simple



**Figure 11:** The part of the plant above the surface is called 'shoot' and is able to regulate its temperature through transpiration. The temperature range in the shoot can therefore be larger and it can change faster. The part of the plant below the surface is called root zone and is not able to regulate its temperature at all. The temperature range is therefore smaller and the roots need to stay cooler.



**Figure 12:** When the lights go on, the air temperature rises and as a result the soil temperature will rise too. It takes a while before the soil warms up (just as it will cool down slowly after the lights are turned off). But it's not only the air that influences the soils temperature. The material, depth (volume) and moisture level also changes its ability to give off or retain heat.

elements into complex organic molecules. Chemical reactions required for cell metabolism and function are the same top or bottom. Other reactions specific to the conversion of light energy to chemical energy also occur and a portion of the cells in the shoot of the plant are like chemical factories that produce more when reactions run faster. The temperature issues remain the same as in the roots; these chemical reactions will go haywire as temperature increases or slows as it decreases. When coupled with the extra incoming heat from the light energy, it becomes critical that the tissue has a system that can control this heat while transferring this to the air, a medium that is much more subject to bigger changes than a denser medium such as soil. These top tissues use oxygen as well at more or less constant values night or day, and they take in carbon dioxide during the light period to convert to the basic blocks of life, carbohydrates. All this the top must do in a temperature range that is subject to much greater fluctuation in a 24 hour period, sometimes 10 degrees or more Celsius that will occur rapidly.

The crown of a plant is the junction of the root tissue and the shoot tissue. In some plants, these crowns are clearly defined and ridged in location, and in others they are not so clear and sometimes variable. This location is like a massive telephone switching station that must take the incoming osmotically generated pressurized water/ nutrient flow from the root, and feed it into a vacuum system that is pulling the flow up and out by the transpiration sinks (areas of negative pressure) generated in the leaf tissues, effectively changing the physics of the flow. The chemical reactions are busy, the temperatures vary, there is a change in the systems involved for temperature control, and oxygen is used in very high levels. A crown exists at the interface of the medium and the air, and to go too far into one or the other (planting too high or too deep) causes problems.

Now, the temperature in the shoot zone, or top zone, has to be right for the reactions to occur. The top itself can slow transpiration or increase it as needed to maintain a temperature in the production tissues. As the lights go on, temps are low and so is the need for cooling. As the day wears on, energy increases and temperature in the air and tissues as well, so does transpiration, which then reverses as the day comes to an end. These temperatures, for example, can start at around 65°F and end up at 85°F before falling back, a 20 degree difference over half a day. In the root zone, these temps may vary from 65°F to 66°F, a 1 degree difference, but the roots must be functional enough in their constant range of conditions to provide everything the top needs, and then does not need, as it goes through a rapid daily change.

### Using this knowledge

Plants took millions of years to evolve to the conditions in which they had to survive and propagate under un-manipulated conditions in nature. Soil temperature and characteristics change with latitude and composition. Plants evolved in specific locations to handle the needs they faced in their drive to procreate. Soil, natural or artificial, changes its ability to give up or retain heat based on material, depth (volume) and moisture level. Very porous material fluctuates rapidly, the same as dry material. Fluctuation decreases as the material becomes denser or contains more moisture, and this is increasingly the case the deeper in the soil profile it goes. Still, the medium is slower to fluctuate, under all these conditions, than the air. If this medium is confined to a bucket, raised bed, or other container, then these fluctuations become more rapid and intense and develop a temperature profile more like air. This medium loses its ability to serve as a temperature control for the root under these conditions resulting in an under-performing root system with a large demand from the top unfulfilled. Shallow rooted plants work with bigger temperature changes closer to average



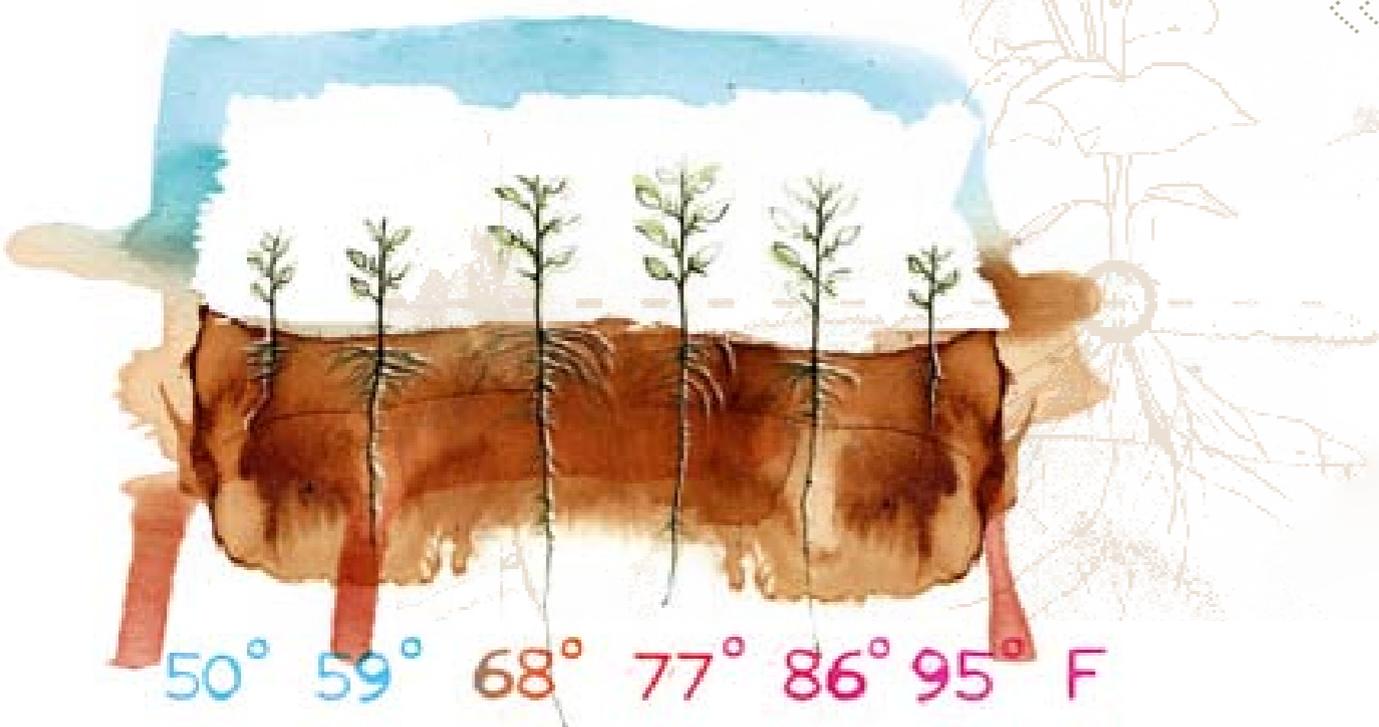
# ROOT ZONE TEMPERATURE AND PLANT HEALTH

ground increases the surface area from which heat can be gained or lost. Plants will shut down (go dormant) when the root system stops most of its function, whether this is a result of cool conditions or hot conditions. This is true in container plant nurseries located in warm, sunny areas. In the summer, the containers heat up from the air and the plants go into a second dormancy even though they are watered and fed to produce maximum production and growth. Even the temperature of the irrigation water or nutrient solution will increase or decrease root function, and a sudden large temperature change will shock the roots. Good growers will warm or chill the water to be in the correct range before irrigating.

Maximum function in a plant is very dependent on temperature and it is a much more complicated story than laid out here. The root and shoot systems have different sets of needs when it comes to temperature: one can function in a bigger range with warmer and faster changes, and the other in a much smaller, cooler, and stable range. Proper plant production has to take this into account. A slower root system will slow top development for any reason including the ability to properly perform the chemical reactions required by slowing the uptake of nutrients. Not just all nutrients but some faster than others which can show as individual deficiencies. Root development and function is best when kept in a range specific to the plant and a good grower will monitor and change these as closely as the grower will monitor and control the air temperature. Everything in a plant is interrelated; even a nutrient issue can develop in a properly fed plant where root zone temperatures are outside of the range. In the end, there are two different and entirely separate environments a plant lives in, and a good grower will pay close attention to both. •

day/night air temperatures, whereas deeper rooted plants deal with smaller fluctuations and cooler temperatures than this average.

The plant root does not regulate its own temperature, and once temperature in the medium goes outside the perfect zone for reactions to occur, can no longer supply the rest of the plant with ideal levels of materials. This is true high or low. The greater the fluctuation in temperatures in a 24 hour period, the more stressed the root system becomes. The more stressed a root system is the more problems a plant will have both physically and pathologically, and will become increasingly susceptible to pathogens and insects. The placing of any root system in a medium above



## Grower's

## TIP #20

By F.F.

### BUSTING A MYTH! WATERING IN VERY POROUS MEDIA

**Recirculation systems that are based on very porous media like clay pebbles, perlite mixtures and rockwool cubes are the least susceptible to oxygen deprivation. The inherent structure of these media guarantees maximum root aeration.**

The high porosity of these mixes is good for fast-growing plants that like oxygen-rich, well-drained soils, but is also potentially harmful because the roots are exposed to the ambient climate. The danger lies in the exposure of the roots to relatively low-humidity air; prolonged exposure will desiccate and damage root systems.

In growing systems where the roots are watered, they and the surrounding medium are covered by a thin film of solution. If the nutrient salts contained in this solution precipitate on the surface of the media particles, the precipitates will wash away back to the main tank in the next water cycle. This is one reason why the entire feeding solution must be dumped and replaced every 7 to 10 days.

The lower the relative humidity in the grow room, the higher the evaporation rate. A common consequence of low relative humidity is the constant rise of the EC of the solution in the main tank. Choosing this sort of system for indoor growing in dryer climates areas does not make the job any easier. A minimum of fifty percent relative humidity in the grow room should be maintained to protect the roots against desiccation.

The key to high-porosity systems lies in determining the correct frequency and duration of watering the root filled highly drainable medium. Most manufacturers of such systems recommend constant 24-hour watering. Under constant watering, the plants manage to grow fairly well but their root system will not develop optimally, which can hinder final crop results. Another solution is to find the right on/off pump sequence.

The pump 'on' time should never exceed fifteen minutes but should be long enough to properly re-wet and flush out the entire volume of the media. To ensure thorough re-wetting it is paramount to spray a minimum of eighty percent of the top surface of the plant basket. Once this has been done, the pump shuts off for some time. When the top layer (the upper third to quarter of the container depth) of the medium begins to dry out (i.e. the colour of the lava rock becomes a lighter terracotta shade), it is time for another irrigation turn.

Usually the 'off' time does not exceed 30 minutes when using clay pebble or similar porous media. Once you have determined the right sequence, expect to reduce the 'off' time gradually as the plants increase in size. The roots should respond by colonizing the medium more densely. Confirmation of this is when roots grow out of the side of the mesh basket and only a few strands of roots that emerge from the bottom stretch down to the drainage depth. This healthier root system will enable your crop to develop fuller and lusher until harvest time.

The frequent switching of your watering pumps puts some strain on your cycle controller. Make sure you invest in a quality unit, as pump failure is the number one weakness of these types of systems.

# Puzzle & WIN

This time – as promised – not the usual spot-the-difference-puzzle, but a very tricky sudoku. Never done a sudoku before? Well, the principle is simple: each row, column and 3 x 3 sub grid must contain the numbers one to nine once.

# Great PRIZES



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

# SUDOKU

Don't forget to let us know what your solution is (sending the middle part of the puzzle to editor@cannatalk.com is enough) and maybe

**YOU will be the lucky one who wins a bottle CANNA RHIZOTONIC!**

## Winner Puzzle #18

We picked a winner at random from all the correct entries we received, and we would like to congratulate.

**Mr. Ricco**

Congratulations with your bottle of CANNABOOST! We will contact you as soon as possible to organise the dispatch of your prize.



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## WHAT'S NEXT

The main theme in the next edition of CANNAtalk will be 'air temperature'. Our researchers will tell you everything about how to measure and regulate it and discuss leaf and plant surface temperatures.

For those who liked our article on genetics and breeding, in the next issue you can read everything about pheno- and genotypes. We also have a nice article about growing leeks and tell you how to make leek soup.

All this and a lot more in the next edition of CANNAtalk!

## CANNAtalk

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