CANNAtalk®
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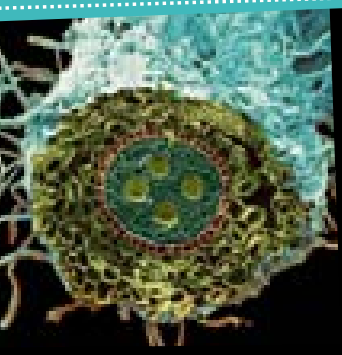
ISSUE 20 2013

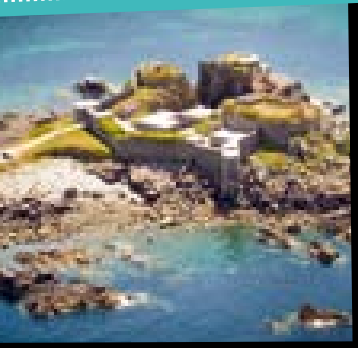
ROOT ZONE TEMPERATURE

The temperature story



REMARKABLE GETAWAYS

Enjoy your dream!



PARSNIP

Tasty and newly hip

And more:

Don & Nicky (NEW) | Questions & Answers

Pests & Diseases | Genetics & Breeding (NEW)

Grower's Tip | Factographic | Puzzle & Win

Contents

HQTalk:

A brand new CANNAtalk is out now! 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 enjoy their stories, so I'm delighted that they are willing to give CANNAtalk readers a little peak into their life, starting this issue!

And we have another, very interesting item called 'Genetics and Breeding'. I've noticed that the CANNA 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 three issues, themes like phenotypes and genotypes, day-neutral plants, and flowering will be covered.

There are lots of interesting new things for you to explore. So please enjoy the new CANNAtalk and don't forget to let us know what you think about this new issue via the CANNAtalk website or the answering card in the back of the magazine.

Karin

A ROOT ZONE ISSUE WITH MORE PAGES AND NEW ITEMS

IS IT WORTH USING AIR INJECTION IN YOUR NUTRIENT TANKS?

OVER THE PAST FEW YEARS, THERE HAS BEEN A MAJOR INCREASE IN THE USE OF AIR INJECTION SYSTEMS THAT ARE DESIGNED TO INCREASE THE OXYGEN CONTENT IN NUTRIENT SOLUTIONS FOR IRRIGATION. IT SEEMS THAT EVERY GROWER HAS OR IS CONSIDERING THE USE OF THESE SYSTEMS IN THEIR OPERATIONS, BUT WHAT ADVANTAGES DO THEY HAVE? WHAT ARE THE ARGUMENTS FOR AND AGAINST USING THESE SYSTEMS, WHAT CONDITIONS SHOULD THEY BE USED UNDER, AND WHAT ACTUALLY HAPPENS TO THE IRRIGATION SOLUTION WHEN THESE SYSTEMS ARE USED?

By Geary Coogler, BSc Horticulture

The basic chemistry of water

Regular water contains not only water molecules (H_2O) but also dissolved solids that can range from substances that are good for plants, like calcium and iron, to those which are not so good, like sodium and lead. Water also contains dissolved gases such as oxygen and carbon dioxide. The amount of dissolved gases held is affected by temperature – the warmer the water is, the less of these gases it will retain – and also by the concentration of dissolved solids – the more dissolved solids there are, the less gases will be held. When water is moving or being stirred so that it comes into contact with air, the amount of dissolved gases will remain at fairly stable levels. However, when water is left standing still, these gases begin to leave the water, by rising up through the column of water so that there is a lack of dissolved air at the lower levels but levels increase towards the top. This process is known as stagnation and it is the main reason that growers might want to aerate their irrigation water.

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. As carbon dioxide (CO_2) moves through the water column, it reacts with ions such as calcium and begins to raise the pH as carbonates are formed. Most public drinking water supplies take advantage of this mechanism by adding calcium carbonate to the water to serve as a pH buffer that both provides better-tasting water and protects pipes from extreme pH levels – both high and low. The buffer offsets pH changes from either acid-forming compounds or alkaline-forming compounds that might be present in the water, ensuring that the pH remains constant while the water is stored and delivered to the consumer.

Additional reactions can also occur with other gases 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 come out of solution or become unavailable for plant usage. This is very important when these gases are present in the ion-rich irrigation water that is used to fertilise plants.

Why dissolved air is important

The atmosphere is made up of many different gases and some of these will dissolve into water. Air dissolved in water is important because it can both sustain and inhibit life. In this situation, the important gases are oxygen, in the diatomic form O_2, and carbon dioxide, CO_2. Oxygen must be in its diatomic (O_2) form to be useful for life. Oxygen in the form of O_2-, the reactive form also known as free radicals, is detrimental to all carbon-based life forms because it is looking for something to combine with and carbon is the optimal

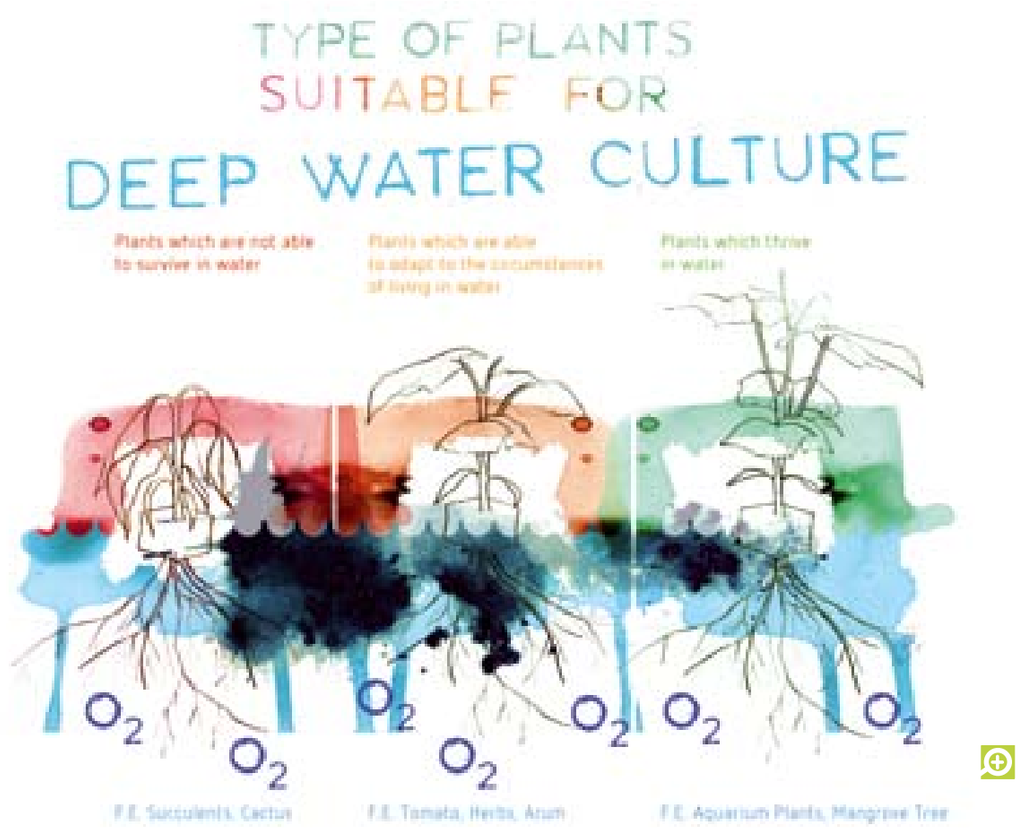


Figure 1: The decision to diffuse air into your tanks depends on many variables. But diffusing air into a tank will only work when the plant can adapt to the lower concentrations of oxygen available to the roots and still function well enough to supply the top.

AIR INJECTION

partner. Oxygen as O_2 is the oxygen source for aquatic life, both plants and animals. Peroxide compounds do not work in the same way because the oxygen released is the reactive free radical (H_2O_2 converts into H_2O + O^{2-}). Carbon dioxide is, of course, not required by the root system but it is needed to influence pH by slowing down these fluctuations.

Without oxygen, anaerobic life forms will start to grow and these can be the causal agents for stagnation and the associated smells, as well as the toxins that can be released and a plethora of diseases.
The roots of the plants growing in water still need oxygen at the correct levels to function properly. Not only the roots but also beneficial micro-organisms require oxygen to survive and thrive. However, the levels they require can differ from terrestrial plants. Although terrestrial plant roots seldom see ambient air concentrations (since the air must first diffuse through the porous structure of the soil), the levels they experience are much higher than the oxygen levels typically found in water.
It is very important to note that different gases dissolve in water at different rates and so will dissolve in water in different proportions to those in the air. For instance, CO_2 readily dissolves in water but oxygen and nitrogen less readily. Water will only hold a given amount of dissolved gases, which means that as more CO_2 dissolves, other gases such as oxygen and nitrogen are driven out. Also, at higher temperatures or higher levels of salinity, a disproportionate 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: it can dissolve into the water from the atmosphere under normal pressure, or it can be forced through the water artificially (oxygen diffusion). While some fish and aquatic plants can extract enough oxygen to survive at concentrations at around 5 ppm, terrestrial plants cannot. Plants that are typically land based will need extra oxygen when grown in a water medium. However, a distinction needs to be made between whether a plant is being grown in water (deep-water culture or aquaponics), or just exposed to water on occasion (other methods).

When deep-water culture or aquaponics is used to grow terrestrial plants, the levels of oxygen dissolved must be raised beyond what would normally be absorbed by simply stirring the water. Depending on the water temperature and salinity levels, this could be a difficult task and the need for oxygen diffusion comes into play. There are some risks in this system especially if it is drawn from an environment that has been enriched with CO_2. This will cause fluctuations in pH, usually upwards as the CO_2 combines with calcium. Additionally, less O_2 will be dissolved because CO_2 dissolves readily and displaces O_2. It is important, then, to draw the air from an outside source and keep an eye on the pH. It will fluctuate and the more available the nutrient package is, the faster and more pronounced these fluctuations will be.

In all other systems in which water is applied and then the supply is stopped while it drains away, including those using clay pebbles, rockwool, sand, soil, peat, coco, or anything else where the roots do not actively sit in water all the time, aeration for oxygenation will not need to take place as intensively as for aquaponics. The air that dissolves into the water naturally, with perhaps some stirring action for long-term tank preparations, will probably do just fine. This will help avoid stagnation, maintain levels of O_2 appropriate for life, and keep the pH from swinging uncontrollably especially where the tank is located in a CO_2-enriched atmosphere. Additional oxygen for root health may well not needed because the action of the water draining will pull air into the pores of the medium and provide adequate levels of O_2 in the film of water around the root surface. Most of the oxygen in the water will not be used since it will not stay long enough to be absorbed except from the solution on the root surface.
What's more, roots that are not submerged the whole

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

time 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 water that moves into a plant. Submerging roots that have not developed under water for longer than twenty minutes will drown them.

In hybrid systems such as ebb and flow (flood and drain), the act of pumping the water up onto the table and then allowing it to flow back into the holding tank is sufficient to keep enough dissolved gases in the system. In environments with high levels of added CO_2, greater than normal levels of CO_2 can be dissolved into the water with similar results as air injection. However, this is nowhere near as rapid as the physical bubbling of air through the solution. It is necessary to keep a close eye on pH issues, and tanks need to be changed more frequently than would be required in non-supplemented rooms.

So, in systems that do not involve submerging the roots in water at all times, 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. This is because oxygen in these systems will mostly come from diffusion in the medium after irrigation: a simple system that stirs the water in the tank for a few minutes every hour or so will be enough to meet the needs of the system. This could be as simple as a diverter pipe in the tank pump which directs a small amount of the pumped water back into the tank. Other devices could include mechanical stirring equipment like that used in the construction industry for paints and other mixing functions.

Figure 3: An air pump.

In truly hydroponic systems with an inert medium that holds little water, such as clay pebbles or Nutrient Film Technique (NFT), O_2 concentrations at or above 40 ppm are required, or better still approaching 60 ppm, and achieving this may require more air to be dissolved and levels will have to be monitored closely. However, the air does not have to come from a diffuser. For aquaponics, because the volume of water will not be conducive to allowing appropriate O_2 levels naturally, the solution used will have to be diffused with O_2.

Air is certainly an important component in irrigation water, but regulation is critical to avoid upsetting the balance of the system. The real question is whether the extra work of diffusing air into the water is actually necessary, or even whether it is doing more harm than good. The grower needs to be smart about what is needed, the results that can be expected, and what the true costs are. For any system except total root submergence, if stagnation is an issue for the grower even with the simpler techniques mentioned here, the answer may well be a smaller holding tank with more frequent renewals.•

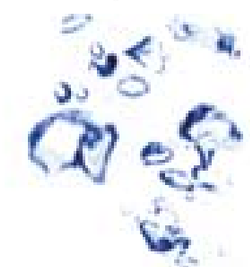


Figure 4: Before sowing parsnips, make a shallow drill in the soil about 1 inch deep. After sowing the seeds, cover them with soil and then firm down. Water the area if the weather is dry. Germination takes approximately three to four weeks.

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

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

Photo Courtesy Peter Stevens

PARSNIP

was easy to grow, plus you could store it for a longer 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 100 g. 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 at 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.

-18 ounces of parsnip
-1 teaspoon fennel seeds, toasted and ground
-½ teaspoon ground cumin
-½ teaspoon chili powder
-½ teaspoon paprika powder
-½ teaspoon black pepper
-2 tablespoons of high heat oil
-1 teaspoon salt

Preheat oven to 250 °C.

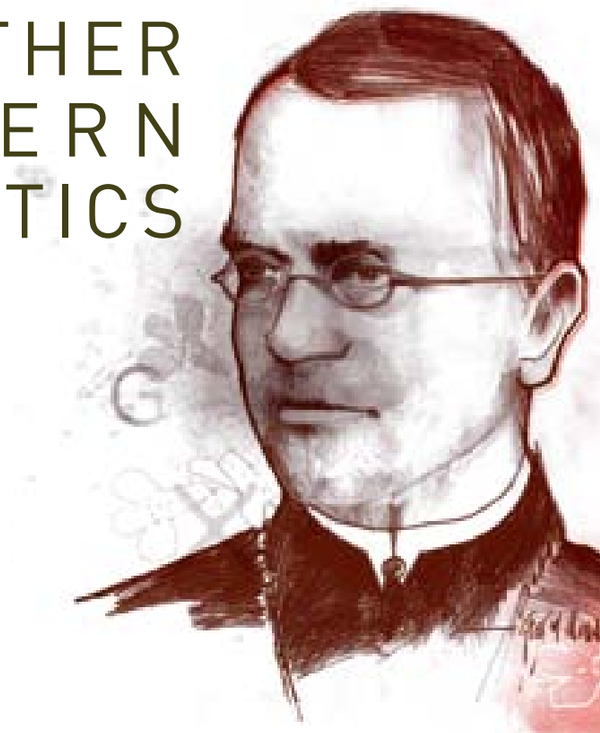
Mix the fennel, cumin, chili powder, paprika, and pepper in a small bowl and set aside.
Pat the parsnip slices with a paper towel and place them in a large bowl, drizzle with oil and sprinkle with the spice mixture. Season with salt to taste.
Place the parsnips in a single layer on baking sheets. Roast 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 scientam 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 colour of the cotyledon (green or yellow), the colour of the flowers (white or violet), the shape of the pods (full or constricted), the colour 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 genotype of the organism. Through sexual

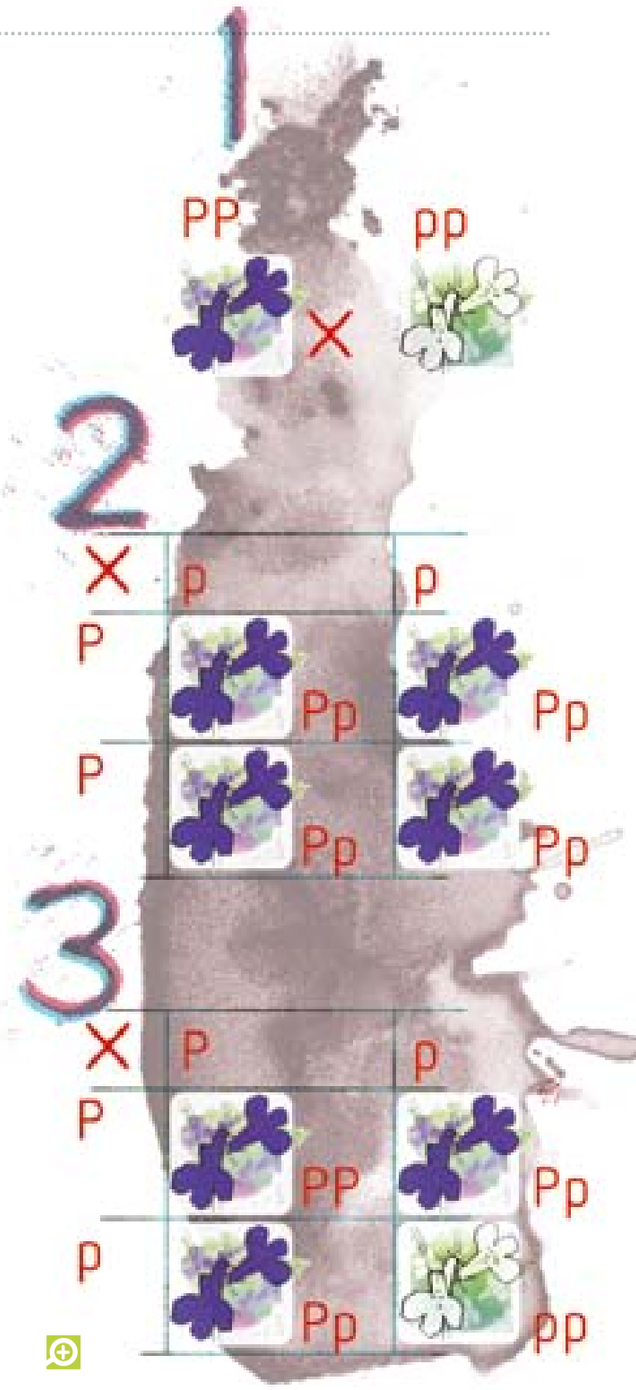


Figure 5: A Mendelian inheritance in a flower with a dominant (P, purple colour) and a recessive property (p, white colour).
1. One parent plant is homozygous for the dominant flower property (PP), the other for the recessive property (pp).
2. In the first generation (F1) all flowers are purple and they 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 Heassly photography.

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 re-appear 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 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).

MENDEL THE FATHER OF MODERN GENETICS

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'. •

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

Photo Courtesy to Darwin Cruz.

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!

1

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: £64.95 **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: £80,- **www.woodlynpark.co.nz**

2

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

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 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: £160,- **www.landmarktrust.org.uk**

3

Utter Inn, Sweden

4

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: £140,- **www.mikaelgenberg.com**

Nature Observatorio, Costa Rica

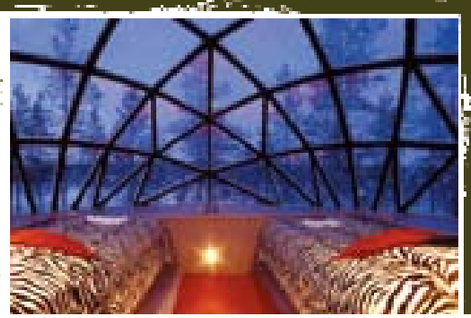
Some hotels are like dreams that have come true, like this tropical forest tree house overlooking the Caribbean Sea. Problem is, you'll never want to leave. Imagine a two-story tree house, with modern conveniences and comforts, powered by solar energy and using collected rainwater, suspended 82 feet 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: £90,- **www.natureobservatorio.com**

5

Kakslauttanen 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 Kakslauttanen 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: £160,- **www.kakslauttanen.fi/en**

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: £185,- **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.

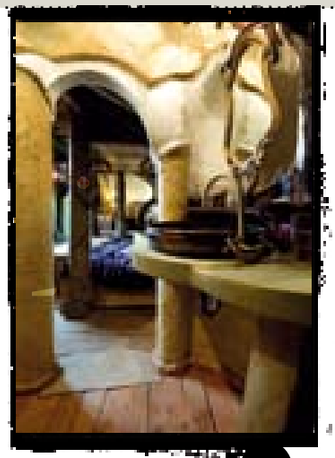
Price: £325,- **www.jul.com**

8

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: £115,- **www.labaladedesgnomes.be**



9

Baumhaus Hotel, Germany

10

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: £200,- **www.baumhaushotel-solling.de**

Fact GRAPHIC

http://dusanbeno.wix.com/dusanbeno#!makro-macro/c3oe

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

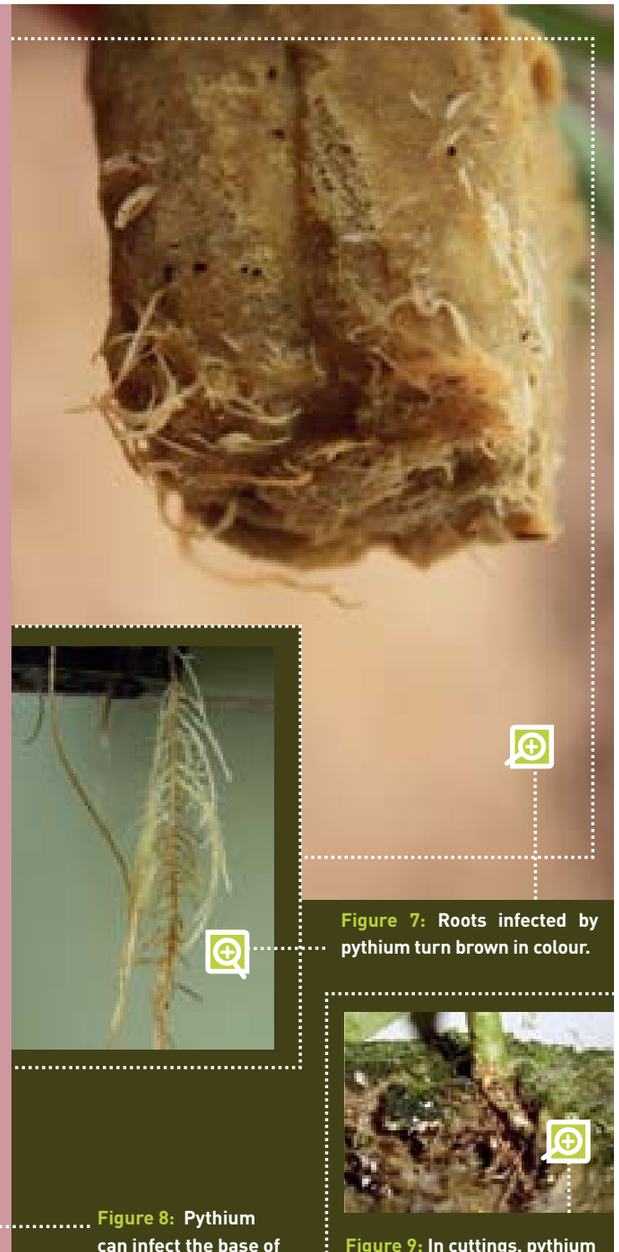


Figure 7: Roots infected by pythium turn brown in colour.

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.

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 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 conditions, such as drought or heat. This means they are able to remain dormant for a number of years until they find a suitable host. It is this resistance that makes it so difficult to eradicate Pythium completely. The best way is to disinfect everything, dispose of the substrate and replace it.

Pythium arrives at our nurseries in irrigation water (especially through its zoospores) or it is transported in soil, substrates, insects or on humans. Once the mycelium is established on the plant, it begins to produce the structures to form new spores, especially in large volumes of standing, non-aerated water.

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 its roots die. 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 happy to answer them!

Question

Hope you can help. My plants are growing too slow. It's okay in my veg room, there they grow fine. But when I move them to the flower room they slow right down and turn into a lighter and duller green and become leggy. The climate is perfect, I have triple-checked. When I move the plants back to the growing table they mysteriously recover within a week. Same climate, same care. I don't know to go from here! Please help me.

Answer

Assuming you are monitoring the environment and watering your plants properly, the next step lies in working out why your flower room is inhibiting the growth rate of your plants. 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 substances release volatile organic compounds over a short period and can easily disrupt growth patterns. Anything that is in your grow room but not in your flower room is suspicious; even cheap plastic can break down under lights to give off toxic compounds.
2. Have you checked the soil temperature in both rooms? Anything under 18°C is definitely part of the problem. Containers sitting on an unheated cement floor often lose too much heat through thermal conduction.
3. Any plant shock such as transplantation, extreme climate, high lighting intensity, or changes in watering strategy could aggravate the room switch.
4. In short what is different between the two rooms? Everything is suspect. Hope this helps!

Question

I'm a great fan of your products and especially Bioboost. I have been dealing with some active invaders. There 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 buggers. Here are a few links to help you do that.

- www.insectid.ento.vt.edu/insect-id/vegetable-pests/index.html
- www.earthlife.net/insects/orders-key.html
- www.koppert.com/pests

If you confirm that these are fungus gnats, you should know that they feed on dead root fungi. Roots usually die as a result of improper watering or poor soil chemistry such as high salt levels. Correcting the root dying issue usually reduces the fungus gnat population. Even more importantly, if populations are high, then you may very well be overwatering. Overwatering even slightly will boost the numbers. Correct moisture levels should hold the population 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 grow hydroponic tomatoes in a lava rock basket with good success, but the EC in the feedingtank keeps rising. Sometimes it doubles in one day and I have to add water to bring it back to the suggested feed concentration. My friend suggested I switch to the CANNA Aqua feed program. Will that really fix my problem?

Answer

Considering the extent of the daily variations you describe, a change of nutrient line would not fix the problem. The rising EC indicates that a lot of water is being lost from the system through plant transpiration or simple surface evaporation. In recirculating systems, this is usually caused by an undersized main reservoir and/or a higher than necessary fertiliser concentration. If the returning solution evaporates too rapidly on system surfaces you will find crystallized salts in areas where this is happening. Covering the feeding tank is also recommended.

Question

I grow in an ebb-and-flow garden and I am happy with the results. However, 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. It's nothing that a good cleaning can't get rid of! But still, I wonder if it might affect my plants...

Answer

This slimy substance is usually a by-product of bacterial fauna living in your reservoir. If your plants are thriving and you regularly sanitize the equipment it will most likely never affect your crop. If you want to reduce the formation of this substance, 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.
- Stop using any compost teas or microbial inoculants.
- Keep the water temperature under 24°C.

Question

I grow organic cucumbers in 6 gallons containers. The vines are tied to a vertical trellis. I use an organic soil mix that is considered good quality and combine it with vermi-compost and good quality guano. The plants grow extremely fast and with lush foliage. 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 start to rot. I grow a large variety of organic plants in that area and never have issues with this problem before. 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. But it also reduces the plant's capacity to withstand fungal and insect attacks. High ammonium nutrition can also interfere with proper flowering and fruit formation. Guano is supposed to be very rich in rapidly released ammonium nitrogen. Try cutting the concentration down or taking that ingredient out of the soil mix. Also, make sure that the foliage is dry going into night, avoid overhead irrigation, and look at other varieties. All this could help too.

Question

I am a dedicated organic gardener and I use the BIOCANNA soil and recipe in my indoor garden. My first few crops yielded mixed results. Since then, I have figured out how and when to water my plants, my crops are healthy and the yields are impressive. The guy in my shop keeps telling me to test the pH of my solution, otherwise some nutrients can get out of whack. I have never done this though. Is it possible to correct the pH in organic solutions even though the products used to correct it are non-organic salts?

Answer

You are right to be careful. Using the BIOCANNA soil and nutrient does not mean you do not have to control pH levels. These products are well-balanced to buffer the optimal root pH but occasionally they need a little help. Certain water conditions can drive the pH beyond the safe limits and to avoid root zone shock, it is sometimes best to keep the pH inside the accepted growing/flowering range above 5 and below 7.

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 12-meter 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 existentialist 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 army of old folk. One guy in particular, Monsieur Bonnet, took a liking to me. He was well into his nineties and rabbited 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.

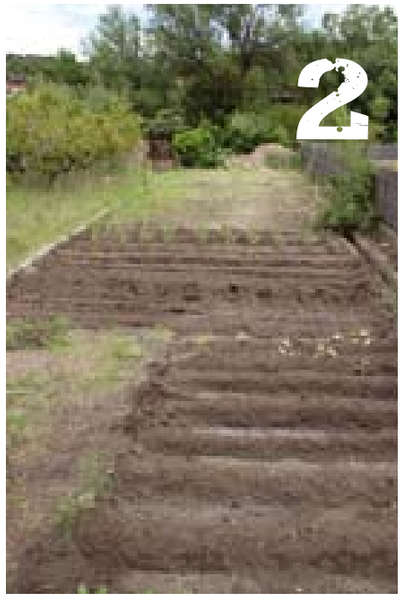
We found a caravan pitch and I focussed on the garden. I soon learnt to start work early. Afternoons were already too hot. But by early May I had my lettuce sown and dozens of tomato and pepper varieties on the go. Sure –I was far from 'self sufficient' but I felt as if I was on the path at last. In 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! •

1 Marmande 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.



ROOT ZONE TEMPERATURE AND PLANT HEALTH

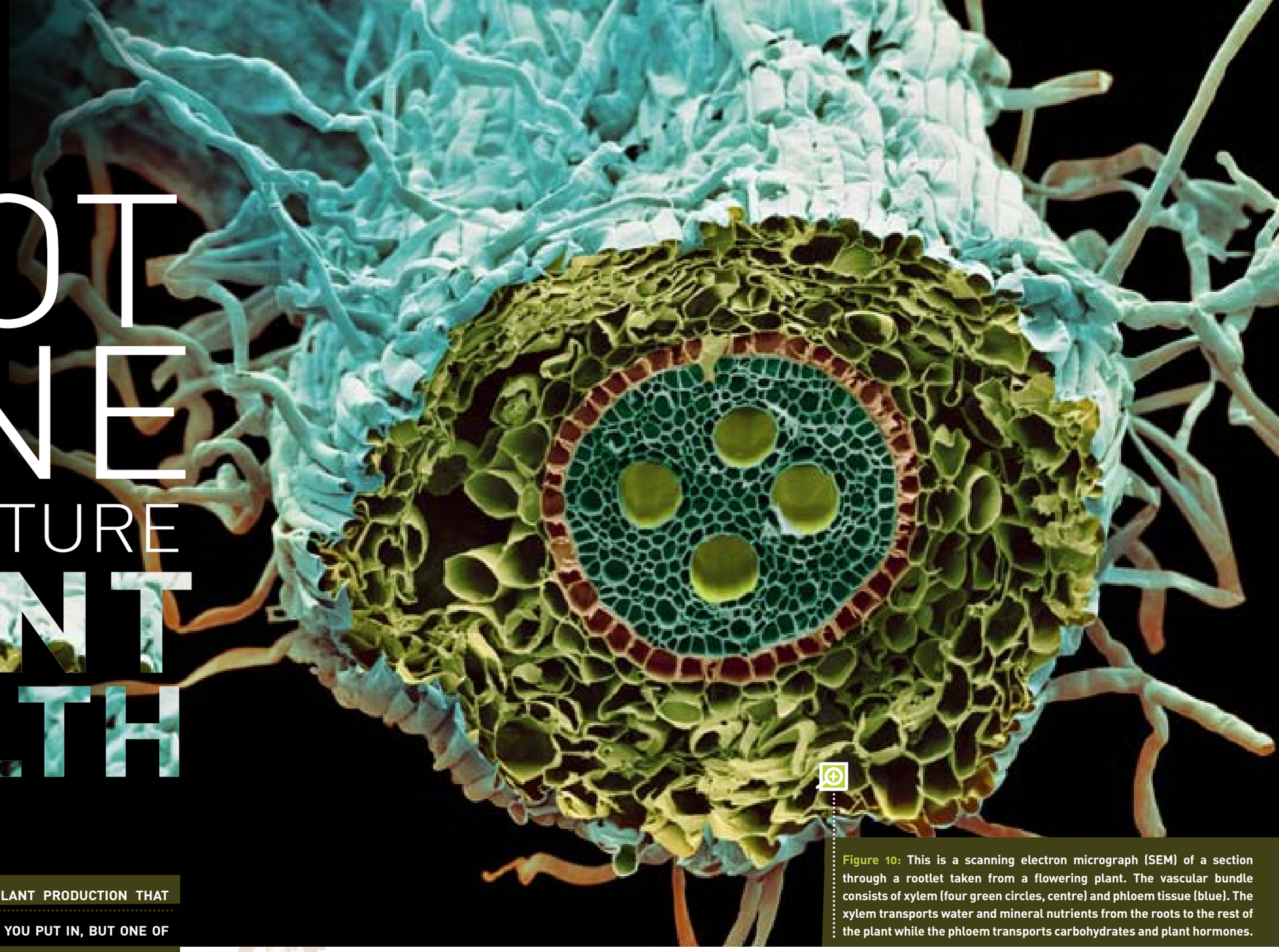


Figure 10: This is a scanning electron micrograph (SEM) of a section through a rootlet taken from a flowering plant. The vascular bundle consists of xylem (four green circles, centre) and phloem tissue (blue). The xylem transports water and mineral nutrients from the roots to the rest of the plant while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

THERE ARE MANY ASPECTS OF CROP AND PLANT PRODUCTION THAT DETERMINE THE SUCCESS OF ALL THE EFFORT YOU PUT IN, BUT ONE OF THE ASPECTS OF GROWING THAT IS MOST OFTEN OVERLOOKED IS THE TEMPERATURE OF THE ROOT ZONE. AFTER ALL, THE ROOTS ARE OUT OF SIGHT, AND BESIDES, WHAT COULD YOU DO ABOUT ROOT TEMPERATURE ANYWAY? SURELY THE PLANTS WILL BE FINE IF THEY ARE ALL AT THE SAME TEMPERATURE. RIGHT? NO, WRONG ACTUALLY, AND HERE IS WHY.

By Geary Coogler, BSc Horticulture

The temperature story

To begin with, there are two main parts of a plant, the roots and the shoots, and one main intersection known as the crown. Although they are made of similar material, have similar components and similar engineering, the function of the roots is, basically, the opposite to the function of the rest of the plant. The crown serves as the switching centre that facilitates the change in function. But the basic chemistry is universal, and although our focus here is on the root zone, the other two parts are affected as well.

The basic purpose of the root system is to take up water and chemical elements that the plant needs to function and which are available in the soil around the roots. The roots' other purposes include anchorage, support and storage, which in some plants may be more important functions than taking up water and nutrients. Roots absorb water and nutrients through the basic process of osmosis: water moves across a membrane into the cells of the plant because of differences in their respective ion concentrations. However, most elements are often actively pumped into the plant cells, and this requires energy. The root also has to guard itself against an excess of certain

ROOT ZONE TEMPERATURE AND PLANT HEALTH

substances and the loss of substances already taken up. To do this, it has evolved protective systems and barriers that do just this.

Obviously, the roots are not there to harvest the power of sunlight. But in fact, they do consume large amounts of the energy that the plant absorbs from the sun. Using this energy involves respiration – the process of taking in oxygen (O_2) and using it to convert the carbohydrates (made through photosynthesis in the top zone of the plant) into energy for use in local processes. The roots have no need for carbon dioxide (CO_2). Respiration gives off heat, and it also requires a minimum temperature to start and continue; if the temperature gets too high, the reactions go haywire. If that happens, the roots will take in water but then they will do their best to retain it and so the process of transpiration (which provides water to the whole of the plant and cools it) will be disrupted. Instead, the roots transfer the excess heat generated from respiration (latent heat) to the surrounding medium. Dense mediums such as soil, sand, and even water, have a large temperature buffer which means that the temperature fluctuations over 24 hours will be minimal under normal conditions.

The basic function of the top zone of the plant is to produce energy from the sun and fruiting structures so that the plant will pass on its genes. As part of this process, it produces energy in the form of complex building blocks known as carbohydrates, and some of these are passed down to the roots so that they can continue to function and grow, providing the plant with the water and nutrients that it needs. 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. Complex systems such as transpiration - simple in their basic concept but wonderfully complex in design - have evolved to move raw materials and finished products upwards, provide a ridged support to the structure of the tissue, facilitate the collection of solar energy and convert simple elements into complex organic molecules. The chemical reactions involved in cell metabolism and function are the same in both sections of the plant – both above and below the ground. Other reactions specific to converting light energy into chemical energy also occur and some of the cells in the shoot of the plant are like chemical factories that produce more when reactions occur faster. The temperature issues remain the same as in the roots; these chemical reactions will occur too quickly as the temperature increases, and they will slow down as it decreases. When coupled with the extra incoming heat from the light energy, it becomes critical that the plant has a system for regulating its temperature and transferring excess heat out into the air, which is subject to much larger temperature fluctuations than a denser medium such as soil. The tissue in the top zone of the plant also consume oxygen at a more or less constant rate, night or day, and they take in carbon dioxide during the light period to assemble the basic building blocks of life, carbohydrates. The upper section of the plant has to do all this in a temperature range that is subject to significant fluctuations over a 24-hour period, sometimes 10°C or more and occurring very rapidly.

The crown of the plant is the junction between the root tissue and the shoot tissue. In some plants, these crowns are clearly defined and ridged, while in others they are less clear. This area of the plant is like a massive telephone switching station that must take the incoming osmotically generated pressurized flow of water and nutrients from the roots, and feed it into a vacuum system that is pulling the flow up and out through the transpiration sinks (areas of negative pressure) in the leaves, effectively changing the physics of the flow. Chemical reactions occur, the temperature fluctuates, there is a change in the systems used for temperature control, and oxygen is used in large quantities. A crown exists at the interface of the medium and the air, and if it goes too far into one or the other (planting too high or too deep), problems will arise.

The temperature in the top zone has to be right for the chemical reactions to occur. The top zone itself can slow down transpiration or increase it as needed to maintain a certain temperature in the production tissues. When the lights go on, temperatures are low and there is less need for cooling. As the day progresses, the energy and temperature in the air and plant tissues increase, as does the rate of transpiration, which then falls back again as the day comes to an end. These temperatures can, for example, start at around 18°C and reach a peak of 29°C before falling back, an 11-degree difference over half a day. In the root zone, these temperatures may vary between 18°C and 19°C – only a 1°C difference, but the roots must function well enough in that constant temperature range to provide everything that the top zone needs, and then does not need, as it goes through the rapid daily temperature change.

Using this knowledge

Plants took millions of years to evolve to the circumstances in which they had to survive and propagate themselves under natural conditions. Soil temperature and characteristics vary according to latitude and composition. Plants have evolved according to the needs they faced in specific locations. Soil, whether natural or artificial, varies in its ability to lose or retain heat based on material, depth (volume) and moisture level. In very porous material, the temperature will fluctuate rapidly, as it will in dry material. But temperature fluctuations decrease as the material becomes denser or if it contains more moisture, and this is increasingly the case deeper into the soil profile. But soil will undergo fewer temperature fluctuations than air under all these conditions. However, if the medium is confined to a bucket, a raised bed, or some other container, then these fluctuations will become more rapid and intense and the

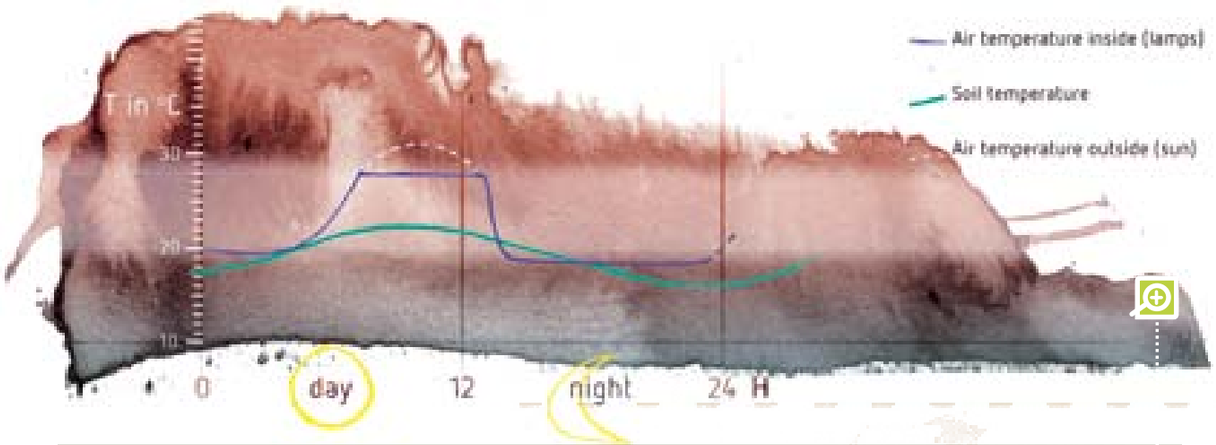


Figure 12: When the lights go on, the air temperature rises and as a result the soil temperature will rise too. It takes a while before the soil warms up (just as it will cool down slowly after the lights are turned off). But it's not only the air that influences the soils temperature. The material,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

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.

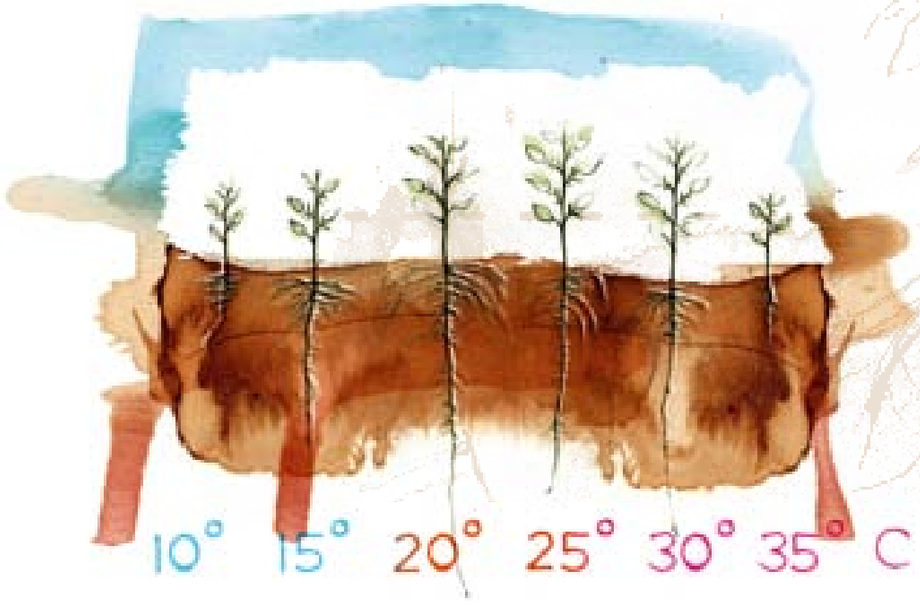
ROOT ZONE TEMPERATURE AND PLANT HEALTH

temperature profile will become closer to that of the air surrounding them. The medium loses its ability to serve as a temperature control for the roots under these conditions, resulting in an under-performing root system which cannot supply the top zone with all it needs. Shallow-rooted plants work with wider temperature fluctuations closer to average day/night air temperatures, whereas deeper-rooted plants have to handle smaller fluctuations and cooler temperatures than this average.

The plant's root system does not regulate its own temperature, and once temperature in the medium strays outside the optimum zone for reactions to occur, it can no longer supply the rest of the plant with the optimum level of water and nutrients. This is the case whether the temperature is too high or too low. The greater the fluctuation in temperature in a 24-hour period, the more stressed the root system will become, and the more problems a plant will have both physically and pathologically, and it will become increasingly susceptible to pathogens and insects. Placing any root system in a medium above ground will increase the surface area from which heat can be gained or lost.

Plants become dormant when the root system stops most of its functions, whether this is a result of too cool or too hot conditions. This is true in container plant nurseries located in warm, sunny areas. In the summer, the containers warm up due to the surrounding air temperature and the plants go into a second period of dormancy even though they are being watered and fed for maximum production and growth. Even the temperature of the irrigation water or nutrient solution will increase or decrease the root function, and any sudden large temperature change will shock the roots. Good growers will warm or chill the water to be in the correct range before irrigating.

Temperature is extremely important for plants to grow and flourish, but all the factors involved are much more complicated than we can go into here. The root and shoot systems have a different set of needs when it comes to temperature: one can function with larger and faster temperature fluctuations, while the other needs a much smaller, cooler, and stable range. Good plant growers will take this into account. A weak or poorly functioning root system will slow top zone development because it will not be able to perform the chemical reactions required by slowing the uptake of nutrients. Not all nutrients will be affected and some will be faster than others, which can show up as individual deficiencies. The root system will develop and function best when kept within a specific temperature range and a good grower will monitor this closely, just as they would monitor and regulate air temperature. All parts of the plant are interconnected and nutrient issues can occur in plants that are being fed properly if the root zone temperatures stray outside the correct range for too long. In the end, there are two different and entirely separate environments that a plant lives in, and a good grower will pay close attention to both.•



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 lave 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 become 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 Great PRIZES

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.

SUDOKU

			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			

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

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

WHAT'S NEXT

The main theme in the next edition of CANNAtalk will be 'air temperature'. Our researchers will tell you everything they know 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 is your magazine, YOUR VOTE COUNTS!

We enjoyed producing this magazine, and we hope you have enjoyed reading it!
Maybe you want to thank us for this magazine, or you just have a question.
Maybe you want to make a suggestion or comment on one of our articles.
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.

Request information

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- ☐ List of shops in my area
- ☐ Send me a CANNA Calendar 2013. I've secretly enclosed 10 pounds in this envelope to pay for it.

Solution to the puzzle:

#20

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