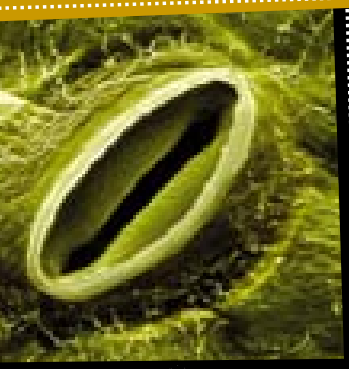
CANNAtalk®
MAGAZINE FOR SERIOUS GROWERS
ISSUE 21 2013

Air temperature and PLANTS

Why it matters



GIRLS ON ROLLER-SKATES

Skate and destroy...

LEEKS

Not only for the Welsh!

And more:

- Don & Nicky
- Questions & Answers
- Pests & Diseases
- Genetics & Breeding
- Grower's Tip
- Factographic
- Puzzle & Win

HQTalk:

Summer is almost here... maybe we'll have some nice warm BBQ evenings soon. Well, most of the time, summer means warmer temperatures and so in this issue of the CANNAtalk, that's exactly what we'll be talking about: Temperature! Temperature plays a really vital role in your overall climate control system. Too hot is no good and too cold is just as bad. In the first research article we will explain the various affects of air temperature on plants. What is the difference between air and plant temperature, for example? The second CANNA Research article will explain to you how you can work with temperature to make your growing a success. But of course, not everything will be about temperature. We have a pests & diseases about atmospheric contaminants, such as volatile organic compounds, ozone and other oxidants. There's also the second part of our series on genetics and breeding where we will explain everything about phenotypes and genotypes. And of course, Don and Vicky will continue to give us an inside in their daily lives, growing cherry tomatoes.

So many things to read and learn in this issue of CANNAtalk. But don't forget to let us know what you think. You can contact us by e-mail or by using the answering card in the back of the magazine.

Remember - the more you read the more you know!

Regards,
Karin

Contents

HOW AIR TEMPERATURE AFFECTS PLANTS

TEMPERATURE IS A KEY FACTOR IN PLANT GROWTH AND DEVELOPMENT. ALONG WITH THE LEVELS OF LIGHT, CARBON DIOXIDE, AIR HUMIDITY, WATER AND NUTRIENTS, TEMPERATURE INFLUENCES PLANT GROWTH AND ULTIMATELY CROP YIELDS. ALL THESE FACTORS SHOULD BE BALANCE. By Tanja Roovers, CANNA Research

Temperature influences the plant in the short term as well as the long term. Not surprisingly, a great deal of research work has been done into proper temperature strategies for efficient greenhouse production. However, the optimum temperature for a plant depends on a range of factors. A plant's reaction to the atmospheric temperature around it depends on which stage of development that plant is in. Plants have a kind of biological clock which determines their sensitivity to temperature.

Differences between air temperature and plant temperature

Most biological processes will speed up at higher temperatures, and this can have both positive and negative effects. For example, faster growth or fruit production is one benefit, in most cases. However, the excessive respiration that occurs is adverse because it means that there is less energy for fruit development and the fruits will be smaller. Some effects are short term, while others

Figure 1: This is a coloured scanning electron micrograph (SEM) of the lower leaf surface of a Garden Rose Rosa sp., showing an open stoma. A stoma is a tiny pore bordered by two kidney-shaped guard cells. Opening the pore allows gases to enter and exit leaf tissues, which is essential for photosynthesis. The pore closes at night or during dry periods to prevent water loss.

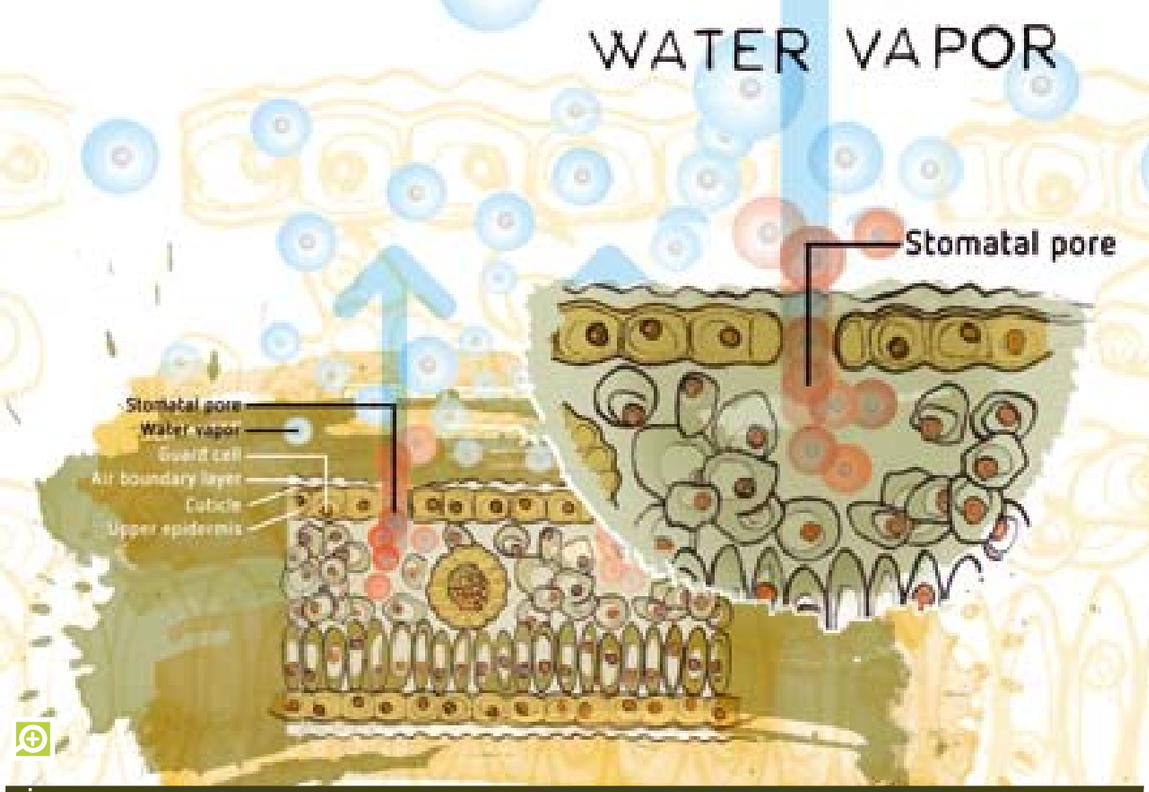


Figure 2: We can think of this using the metaphor of traffic on a highway. The stomata are the exit routes that allow the traffic to flow off the highway. When there are lots of cars at the opening of the exit roads, the cars exiting have to slow down and traffic builds up. When there are fewer cars, the movement of traffic can speed up. The same thing happens with the air molecules, and the water vapour molecules in the air. If there is a higher concentration of these around the stomata (the exit routes), then they can exit the stomata less quickly and they will get backed up. This is what happens when VPD is high. This means the plant can cool less effectively and it induces stress. Additionally, water will condense forming a thin film on the surface of the leaf, and this is a perfect environment for pathogens.

are longer term. The plant's assimilation balance, for example, is influenced by the temperature and is affected immediately. Flower induction, on the other hand, is determined by the climate over a much longer period.

Plant temperature and air temperature are not equal because plants are able to cool off through evaporation and warm up through irradiance. Plants seek to reach their optimal temperature, and a balance between air temperature, relative humidity and light is important in this. If light levels are high, the plant will heat up, resulting in a difference between plant temperature and air temperature. To cool down, the plant's transpiration rate must increase. As well as temperature, the transpiration rate depends on environmental conditions such as light, the level of atmospheric CO_2 and relative humidity, but also on the plant species.

Plants consist of different parts which all react differently to temperature. The temperature of the fruit is closely in line with that of the air; when the air temperature rises, fruit temperature also rises and vice versa. However, the fruit temperature will fluctuate less than air temperature and it will also take longer (sometimes a couple of hours longer) to rise or fall than the air temperature does. The temperature of the flowers, by contrast, is higher than air temperature or leaf temperature, and the petals transpire at a much lower rate than the leaves. The plant temperature at the top of the canopy will undergo larger fluctuations than that at the bottom of the canopy. The top will also heat up more easily through irradiance and therefore reach higher temperatures than the air when light levels are high.

Vapour Pressure Deficit

The relative humidity of the environment depends on temperature and wind speed. Higher temperatures generally lead to increased transpiration. This is partly because the molecules move faster, but warm air can also accommodate more water vapour. When there is no air movement, the air around the leaves will become saturated with water vapour, slowing down the process of evaporation. If the air is saturated with water, a film of water will condense on and around the leaves providing a good environment for pathogens, which can attack the plant. The difference in water vapour content between the air and the saturation point is called the vapour pressure deficit (VPD). The higher the VPD, the more water the plant can give off through transpiration. However, if the VPD is too great, the plant can become stressed because it is unable to replace the amount of water which it is losing through transpiration. This does not cause a problem for short periods – the plant will absorb enough water the following night to recover. But when the VPD stays high for a longer period, the plant is unable to recover the next night and irreversible plant damage such as burned leaves or petals can occur. Leaf thickness measurements give a visual impression of the potential of a plant to recover. The leaves actually become thinner during the day because they lose water through transpiration, but when a leaf is thinner on one night than it was the previous night, this is a sign that the plant has failed to recover. So it might seem tempting to keep VPD levels low to avoid any damage, but under these conditions the plant is not stimulated to grow and be active, which can have negative results when the plant is confronted with situations of stress. Overall, a comparison with the rev-counter of a car can be made. As the engine speed increases, the needle of the rev-counter goes higher and enters the red zone. This will not damage the engine immediately, but it will if the needle stays in the red zone for too long. For most plants, the VPD should be between 0.45 and 1.25 expressed in kilo Pascal (kPa the unit for pressure) with an optimum of around 0.85kPa. The VPD follows more or less the same pattern as the ambient irradiance levels; in the morning it rises, as the sun starts shining, reaching a peak around noon and then gradually decreases again. To calculate the VPD, the air temperature, plant temperature and relative humidity must first be known.

Stomata

Plants are able to regulate the process of transpiration and cooling by using specialised plant organs called stomata. The stomata are specialized cells in the leaves which can open or close, limiting the amount of water vapour that can evaporate. The higher the temperature rises, the more the stomata will evaporate when they are open. It is difficult to measure the aperture of the stomata, so we can use the VPD to estimate this. As the stomata open wider, more gases can move into and out of the leaves. Environmental factors influence the rate at which this process (stomatal conductance) occurs – for example, higher relative humidity leads to more rapid conductance, while higher CO_2 levels will depress the rate of stomatal conductance. But conductance is also influenced by factors other than environmental ones, such as plant hormones and the colour of the light (the wavelength) that the plant is receiving. The plant hormone abscisic acid will regulate the ion concentration in the stomata and cause the stomata to open very quickly, within just a few minutes. Light at shorter wavelengths (around 400-500 nanometre (nm)), which is blue light, causes the stomata to open wider than light at longer wavelengths (around 700 nm), which is red light.

Optimum day and night temperatures

Different processes occur in the plant during the day and at night, and the optimum temperature for the plant will differ accordingly. The transportation of sugars occurs mostly during the night and mainly towards the warmer parts of the plant. The leaves cool faster than the fruits and flowers, and therefore most of the available energy goes to these parts of the plant, which need the energy to grow and develop. The optimum day and night temperature combinations were investigated in the world's first air-conditioned greenhouse, a phytotron, at the California Institute of Technology in 1949. The experiments demonstrated that tomato plants grew taller under a combination of a high temperature during the light period and a lower temperature during the dark period than when the temperature was kept constant. This ability of the plants to 'distinguish' between temperature variations during the day and night is called thermoperiodism, and it has an effect on flowering, fruiting and growth.

The amount of sugar that is transported to growing tissue, where the energy is needed to fuel higher levels of respiration, can be restricted when night temperatures are higher, and thus growth can also be restricted. It was also found that stem elongation can occur with a combination of high day-time temperatures and low nocturnal temperatures. A low nocturnal temperature improves the water balance in the plant which is the main reason for increased stem elongation. So temperature can be used as a tool for regulating plant height, but low nocturnal temperatures can also save energy. The term thermomorphogenesis is used to describe the thermoperiodic effects on plant morphology.

The optimum air temperature also depends on the light intensity and the amount of carbon dioxide in the air. Plants function in a similar way to cold-blooded animals, in that their metabolism and the rate of photosynthesis increases in line with the ambient air temperature. When temperatures are very low (how low depends on the plant variety), hardly any photosynthesis will occur, regardless of how much light there is. The rate of photosynthesis increases as the air temperature rises. When light and temperature are in balance, the level of ambient CO2 will be the limiting factor. If there is enough CO_2 available, the rate of photosynthesis will increase as the temperature rises, although other factors do also play a role, such as the enzyme RuBisCo. RuBisCo is critical for photosynthesis. In some cases, a process known as photorespiration will occur – this is when the RuBisCo binds with oxygen instead of carbon dioxide, as would happen during normal photosynthesis. The level of CO_2 and the optimum temperature will both be lower at low light levels than at high light levels, and enzyme activity also increases at higher temperatures.

Drop and temperature integration (DIF)

The concept of DIF concerns the relationship between day and night-time temperatures. The effects of diurnal temperature alternation on the lengthways growth of plant stems depends on the difference (DIF) between day and night-time temperatures (which is calculated by subtracting the night-time temperature from the day-time temperature), rather than on separate and independent responses to

Figure 3: Most of the water in the atmosphere is present in the form of water vapour. Water vapour is invisible, but we can notice its presence through how comfortable we feel (higher humidity makes us feel sticky and less comfortable). Visibility is also affected by how much water vapour there is in the air. Clouds are visible because the water vapour they contain has cooled off to the point where the water molecules begin to condense and form tiny droplets of water or even ice crystals in the air. We can see these as clouds.

Figure 4: Vapour Pressure Deficit (VPD) can be compared with a rev-counter in a car. As the engine speed increases, the needle on the rev-counter turns and enters the red zone. This will not damage the motor immediately, but it will if the car continues to drive like this for a prolonged period. The same applies for plants: when the VPD is too high for a longer period of time, the plant is not able to recover the subsequent night and irreversible plant damage can occur (burned leaves or petals).

day and night-time temperatures. In other words, it is this temperature difference that is important, as well as which is higher – the night temperature or the day temperature. The growth of foliage is not greatly affected by DIF, but the growth of the internode stem sections is affected. Plants grown under a positive DIF are taller than plants grown at a zero DIF, and plants grown under a zero DIF are taller and have longer internode sections than plants grown under a negative DIF. Other important morphogenetic responses to negative DIF (i.e. when the day-time temperature is lower than the night-time temperature) include shorter petioles, flower stems, flower peduncles and leaves. Differences in internode elongation and leaf expansion are the result of differences in the process of cell elongation and/or cell division. When DIF is negative, both of these processes are inhibited and this may be the result of reduced gibberellin activity in the sub-apical meristem (a plant tissue responsible for growth). Gibberellin is a plant hormone which stimulates plant growth. DIF has the greatest effect on stem elongation during the period of rapid growth, so seedlings are more sensitive than adult plants to differences between day and night temperatures. Negative DIF at an early stage of stem elongation is therefore important to limit plant height.

Stem elongation can also be caused by a short temperature drop (of about two hours) during the 24-hour daily growth cycle, generally at or just before the first daylight, but during the dark period. Responsiveness to temperature changes seems strongest during the first hours of the light period in long-day plants, short-day plants and day-neutral plants. Thus a temperature drop during the last two hours of the night will affect plant height. This is usually easy to accomplish in greenhouses during the autumn of cool climate zones because of the naturally low night temperature.

The variation in the sensitivity of stem elongation to temperature within the day period and night period may be controlled by an endogenous growth rhythm. A circadian growth rhythm (lasting about 24 hours) was identified in 1994 in Chrysanthemum. Plant stem elongation is not constant during a 24-hour light and dark cycle. Both short-day plants and long-day plants grown under flower-inductive conditions elongate more rapidly during the night than the day. Orchids need a period of low night temperature to flower.

Temperature integration is one strategy used by growers. A minimum and maximum temperature for the crop is determined and the temperature is allowed to vary as long as the average temperature over a longer period is maintained. This strategy utilises natural heat as much as possible.

Air temperature is a primary environmental factor that affects plant development and growth rate. However, air temperature is never an isolated issue. Every factor in plant growth interrelates with every other factor and the challenge is to find any weak link in the chain. This article has explored many of these factors, but there are still others which are just as important, such as water balance and therefore, indirectly, transpiration. Everything that is or will occur in the plant does so under the first control point of air temperature; getting this right is the first step on the long road to successful crop production.•

GrowIT

YOURSELF

Figure 5: In their second year, each leek has a wonderful spherical flower. This produces hundreds of seed pods which you can use to grow more leeks.

THAT'S WHAT THE SAXONS MUST HAVE THOUGHT IN 640 A.D. WHEN A WILD BUNCH OF WELSH WARRIORS WORE LEEKS IN THEIR HELMETS DURING THE BATTLE BETWEEN KING CADWALLADER OF WALES AND THE SAXONS. THE WELSH WON, AND THE LEEK BECAME THEIR MASCOT OVERNIGHT. THEY EVEN PUT IT ON THEIR COINS. BUT WE JUST THINK LEEKS TASTE GOOD.

By Marco Barneveld, www.braindrain.nu

The leek is an emblem of pride in Wales, and Welshmen still wear a leek to commemorate their national day, St. David's Day on March 1st. But since the leek is such a delicious vegetable, they eat them too. Leek broth or cawl is a traditional Welsh dish for St. David's Day.

But the Welsh are not the only ones to have a thing with Allium porrum, as the leek is known in scientific circles. There have been others too. After the children of Israel left Egypt, where services were sometimes paid for in leeks, the vegetable was one of the foods mentioned in the book

Figure 6: **Did you know that leeks are very easy to grow from seed?**

LEEK!!

of Numbers in the Bible as being greatly missed. In Hebrew it is called karti, which is a pun on another Hebrew word yikartu, meaning 'to be cut off'. Thus, the Jews eat leeks at Rosh Hashanah, the Jewish New Year, to symbolise a wish for their enemies to be 'cut off'.

Poor man

Allium porrum is a member of the onion family, but its flavour is much more refined, subtle, and sweet than the standard onion. Thought to be native to the Mediterranean area and Asia, leeks have been cultivated for over 3,000 years and have long been popular in Europe, although they have had a reputation as a poor man's food.

European chefs call leeks 'poor man's asparagus.' Asparagus is actually a very distant relative of the leek, once residing in the same Lily family as onions, but is now belonging to a distant branch of the Asparagaceae family. In France, the leek is known as poireau, which interestingly enough is also a derogatory term meaning 'simpleton'.

The soldier of health

If you read up on the health benefits of the leek, you will realise that you are definitely not a simpleton if you eat this delicious vegetable. The particular combination of nutrients in leeks is very helpful in steadying an elevated blood sugar level. These include vitamin C, vitamin B6, foliate, iron and manganese. These nutrients do not slow down the absorption of sugars from the intestinal tract, but lower sugar levels simply by ensuring that the sugars are properly metabolised in the body.

A regular intake of leeks has been associated with a rise in the HDL (High Density Lipoprotein or 'good' cholesterol) levels and a corresponding decrease in the LDL or Low Cholesterol Lipoprotein levels. Maintaining this balance in the body is essential because it helps prevent both the onset and the progression of fatty deposits in the blood vessels in the body. It is these fatty deposits that lead to diabetic heart disease in humans, and they can even result in a heart attack or stroke. A regular intake of Allium vegetables like leeks also bring down high blood pressure levels, another major factor in the occurrence of strokes and heart attacks.

Leeks are known to promote good health in other ways. Consuming the vegetable has been shown to considerably reduce the risk of colon and prostate cancer. Studies have shown that the vegetable helps to prevent ovarian cancer in females. A good source of dietary fibre, leeks energise the human body to perform many types of biological functions like digestion and metabolism.

How to plant your leeks

The easiest method is to sow the seed directly into the soil between March and April. Alternatively, you could cheat and buy ready-grown seedlings – many nurseries offer a good range. By choosing the variety carefully, you could have a plentiful harvest of leeks from mid-summer until the following spring. These are the varieties you could try: Musselburgh - a winter hardy with white stems, which you can pick from December to April. Monstruoso de Carentan – a French heritage leek with short stems that can be harvested from October to January. Pandora – with slightly blue leaves and long white stems which crops between September and January.

In your vegetable patch, seeds are best sown in rows, 12 inches apart. Mark a straight line and use the corner of a rake to make a shallow groove in the soil, about 0.4 inch deep. Sow the seeds thinly along the trench, cover with soil, water and label them. When the seedlings have three leaves each, about four to five weeks later, thin the leaved plants every 6 inches. The seedlings you remove could be used to plug gaps elsewhere.

Alternatively, buy ready-grown plants. They will arrive as young seedlings during May and June, ready to plant out straight away. To do this, make a hole with a dibble, 8 inches deep, and drop a seedling into each. Using a watering can, fill the hole with water and allow it to soak away. This will draw enough soil over the plant to cover the roots and produce wonderful blanched stems as the leek grows. Keep plants well watered, especially during dry spells. Mulch will help to retain moisture over the summer.

Harvest from summer onwards. Harvest leeks by lifting carefully with a fork, being careful to avoid damaging neighbouring crops.

...A LEEK!!

TIPS

- **People with untreated or existing kidney and gall bladder problems should avoid the consumption of leeks on a regular basis. This is because the vegetable contains significant levels of oxalates, which, when they become too concentrated in the human body, crystallise and create health problems.**
- **In their second year, each leek has a wonderful spherical flower, which could easily qualify as an ornamental specimen. The flower produces hundreds of seed pods. These you can use to grow more leeks!**

Grow it yourself

So a nice patch of leeks in your (urban) garden would certainly be a pleasant addition for your green fingers to care for.

Choose a sunny, sheltered site with well-drained soil. Because they will sit in the soil for a long time, they are an ideal crop for food production, although many have fantastic foliage that also makes them an attractive vegetable to grow in flower borders.

If possible, prepare the soil for planting in the winter. Till the site well, removing weeds and working in plenty of good composted manure to improve its ability to retain water.

Leeks can be planted in heavy soil, but you can improve drainage by mixing in some horticultural sand. This is a hungry crop, so spread a general all-round fertiliser over the soil a week or so before sowing and rake in. A rate of 2oz per square meter is ideal. •

RECIPE LOVELY LEEK SOUP

llt's light and lovely this leek soup. Lots of people blend the vegetables after cooking but the texture of soft leek is so delicious that in our humble opinion, this is a bit of a waste.

You will need:

-2 shallots, diced
-2 cloves garlic, diced
-Bit of butter
-A dash of olive oil
-2 medium-sized leeks
-1 large carrot
-Some dried oregano
-2 bay leaves
-1 litre vegetable stock

How to cook? Heat your pot and add the oil and butter. Let the butter foam. Add your garlic and diced shallots and cook them until they have a bit of colour. Add the leeks and sliced carrot and stir. Add the oregano and bay leaves then cook for 10 minutes on a medium heat slightly covered. Add the stock but do not cover the leeks, bring to boil and allow to simmer for 10-15 minutes until the leeks are soft and delicious. Add the rest of the stock and simmer for 7 min.

CAN WE COME FOR LUNCH?

We could talk and write almost endlessly about the subject theme 'genetics and breeding'. And that's exactly why we have chosen to devote a series of items to the subject. We've already brought you a general article about the rules of Mendel and his discoveries in the previous edition of CANNAtalk, and this time we are going to discuss phenotypes and genotypes. In future editions, we are going to look at day-neutral plants, flowering and how to protect genes.

GENOTYPE AND PHENOTYPE EXPLAINED

HUMANS CATEGORISE THINGS, ALL THINGS, OR AT LEAST EVERYTHING THEY CAN. IT BRINGS ORDER TO THEIR WORLD AND ALLOWS THEM TO DEFINE THEIR RESPONSE TO STIMULI (AN EVENT THAT OCCURS WHEN TWO OR MORE THINGS INTERACT) RECEIVED BASED ON THE CATEGORIES INVOLVED, AND ALLOWS THEM TO UNDERSTAND THE INNER WORKINGS OF EVERYTHING AROUND THEM. By Geary Coogler, B.Sc. Horticulture

For scientist intent on figuring out why things work the way they do, and to attempt to affect the way these things work, Genotype and Phenotype, while certainly a physical thing, is just a way to categorise life forms with this in mind. They are basically just categories.

The problem with any category is defining the terms, or the specific characteristics, that define the category. The simpler, less involved system is always the best. Whether it categorises based on a single component or a broad number of components, it becomes the most important choice because it ultimately defines the number of categories that must be considered. When a non-organism (anything not considered a living organism) is described and categorised, it can be done in great detail with a few categories, but not so with anything considered alive.

Classification Systems

The complexity and diversity of living organisms is such that any system attempting to categorise life must be both necessarily large and intricate. When science classifies life into relevant categories, it does so by grouping similar traits into the same category then grouping similar categories into another group, and so on, building a hierarchical classification system. Like a file system where a particular file is located in a certain room, on a particular wall, at a definitive side, in a special cabinet, in a definite drawer. Under this system, the pea plant that Mendel used in his research (Pisum sativum L.) is the species sativum in the genus Pisum of the family Fabaceae, and so through four or more levels till it and every other plant is placed in the Kingdom category of Plantae. These levels, or categories, to which P. sativum L. belongs, include what are considered related organisms from the smallest clovers to the largest Golden Chain Tree or Magnolia, including roses. Ultimately every plant is related at the most basic of levels. To classify different plants into this system, Phenotype is the work horse, and is certified by genotype.

Genotype and Phenotype are both classes to which

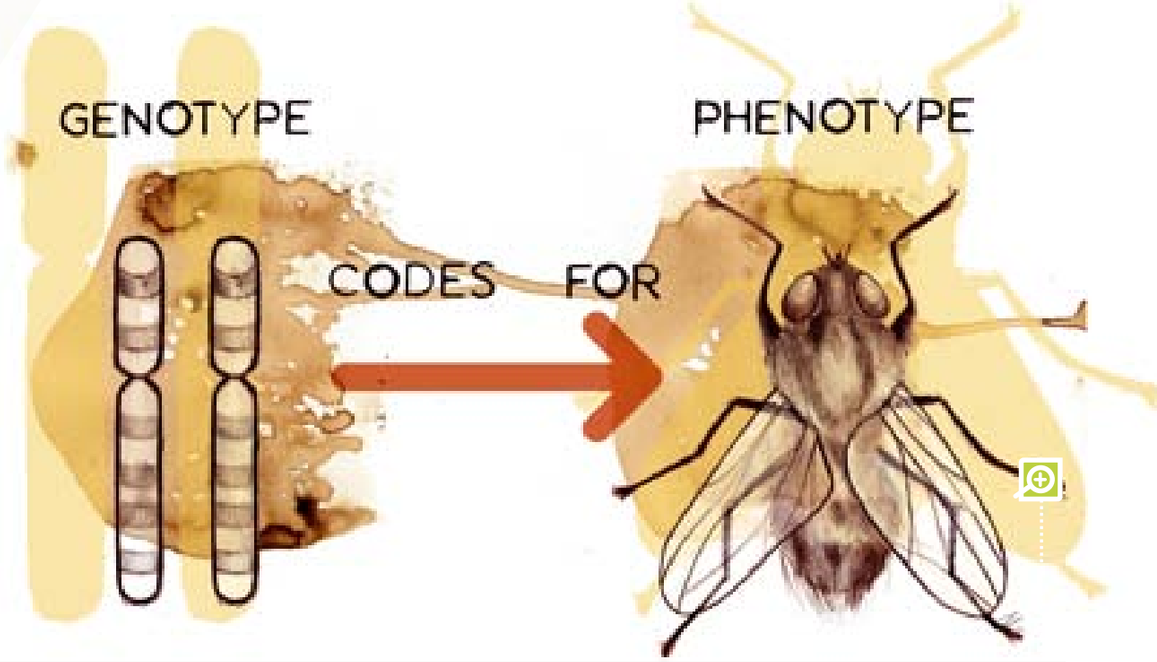


Figure 7: The genes, which reside as groups of specific molecules or nucleotides on the DNA strands, determine the potential of the phenotype as it may be affected by outside variables.

organisms belong. Genotype serves to describe the genome of the organism which is the actual collection of physical material, made up of DNA (in sequence-genes) as received from the parent(s) of the organism at its conception. The Phenotype serves to describe the phenome of the organism which is the manifested physical properties of the organism (physiology, morphology and behaviour). In other words the genome is the exact sequence of the Genes in a given organism, and the phenome is the 'everything else' of the organism including the way it looks, acts, metabolises, and how it is comprised. The phenome of the organism is the end result of the genes expressing themselves while being acted on by everything else not a gene. Mendel's Laws, as laid out in the last CANNAtalk issue, make clear that there are two separate and distinct causal pathways in play, heredity and developmental.

A gene is (very) basically a segment of a DNA strand that is itself composed of a series of four basic nucleotides. A new molecule codes itself along these sequences with the corresponding nucleotide to form new DNA (double helix that needs 'unzipping' and serves as the master template) for inheritance or RNA (almost always single strand is the immediate link from a gene(s) to code everything else to come) that makes everything else work. By one path, the new DNA is coded and passed directly on to the next generation unaltered. Then in another path, the newly coded RNA enters the metabolic pathways of the cell and becomes the way the genetic information is carried into the physical or Phenome world of the cell through its synthesis of proteins, enzymes and other metabolites. While occasional damage occurs to the DNA sequence, which if uncorrected becomes a part of the genome, it is rare. Changes to the copied RNA is different as it can be changed by accident

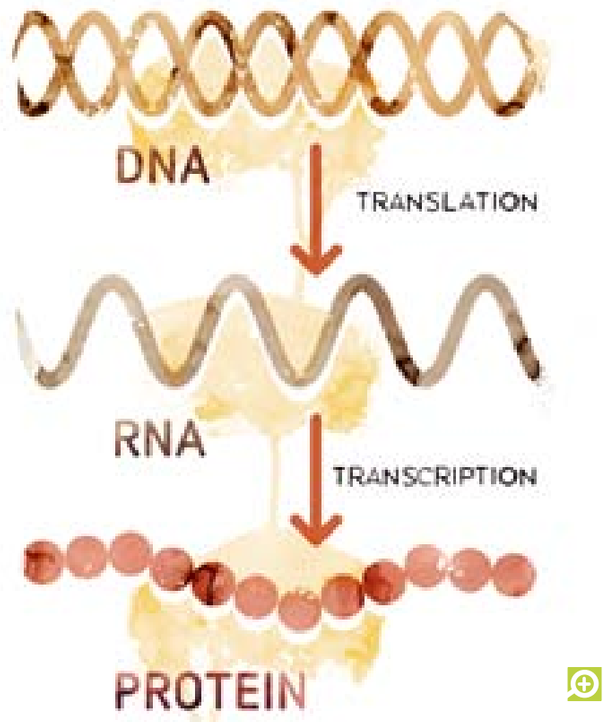


Figure 8: The chemical sequence in the DNA is translated into a sequence on the RNA which then codes for a specific protein that basically mirrors the code and, along with all the other specific proteins, becomes the life form and its processes.

GENOTYPE AND PHENOTYPE

from the time it is coded to the time it performs its function, and these changes can be triggered by any number of means. It is this separation in paths that allows the genome to be a cause of the phenome while protecting the genome from being influenced by the phenome.

There are some subtle exceptions such as viruses that code their genomes in RNA. RNA controls, transcribes, monitors and repairs the DNA. A classic example (borrowed from a friend) is that the DNA is like an encyclopedia with each gene being a chapter and the entire volume stored in a safe. RNA is working copies of the gene chapters that translocate to other areas to make the proteins and enzymes necessary for life function based on the text it is a copy of. While protected, the pages and text can fade and need repair, and if the repair RNA leaves subtle changes then a different copy of the text becomes permanent record.

Partial Typing

The developmental pathway is given its marching instructions by the genome but its expression is limited by the physical reality the organism finds itself in. If, for example, an organism is keyed for being tall, this may not happen if food supplies (environmental) are limited and gene expression will not reach what it could have achieved. This holds true of almost all the gene expression in the developmental pathway. In some instances, certain animals and plants can change even the most basic of expression, such as sex, based on environmental pressures.

It is equally true that the genome with which an organism starts life will not be exactly what it was at the end of its life. Subtle changes occur from mutations caused by things such as poor replication or outside influence from environmental factors such as radiation or chemicals. Even in the case of clones or twins, while they may start out identical, at the end there will be differences in the genome. It is estimated that humans have over three million differences in nucleotide arrangements between random members (not twins).

Given what is stated in the previous paragraphs, the reality is that because of the potential changes, and because of the way sexual reproduction works, everything but clones and twins have an unique genome. There is only one exact Genotype that the organism will fit and it will have only one member at least at the beginning (possible cloning). Phenotype, being influenced by the conditions the organism develops in as well as that unique genome, also has only one member or phenome in its set. Even identical twins with exact copies of DNA will enjoy subtle differences in development. Because of this, the system is actually one of partial genotype and partial phenotype. Organisms are classified based on the most important characteristics to be found in both a Genotype and a Phenotype. The most recognised classifications are done from Phenotype as that is what can be observed, but modern science also uses Genotype classifications that back up a certain classification, or allows for further sub classes to be formed. And since the genome can be matched to the phenome, it becomes possible to understand how certain differences must be approached to affect change, and what is really possible.

The simplest way to view the differences in the two concepts of the pathways for the development of life is by thinking of it all as a puzzle. In this case, the genome describes three variables, piece count, number of distinct piece shapes, and that the surface of the piece has a design; so all 1000 piece puzzles of a certain shape and design fit into one box or genotype. When the puzzle is made by using 100% of the pieces, fitted in the correct way, the puzzle is capable of achieving a certain look, or phenome, say a mountain scene in size X, but if a piece is lost, the design on a piece changed, or piece shape modified by the assembler, then the final appearance, phenome, will be slightly different than the next puzzle set in this same Genotype, but still will be the same mountain scene in size almost X. This final appearance is the phenome and phenotype. Considering partial typing, the Phenotype would be a 1000 piece puzzle with this view of a mountain scene, even though it might be missing a piece or so, or the colours are faded, or one of the pieces does not fit exactly.

While the concept behind Genotype and Phenotype can be a bit difficult, it remains important that these distinctions be made. This is how the processes and parts are understood and how future interactions are planned. The seed industry farmers alone have employed these concepts since long before Mendel wrote about his little garden at the Abby. Without these distinctions, the Green Revolution would have been little more than a loud party next door. •

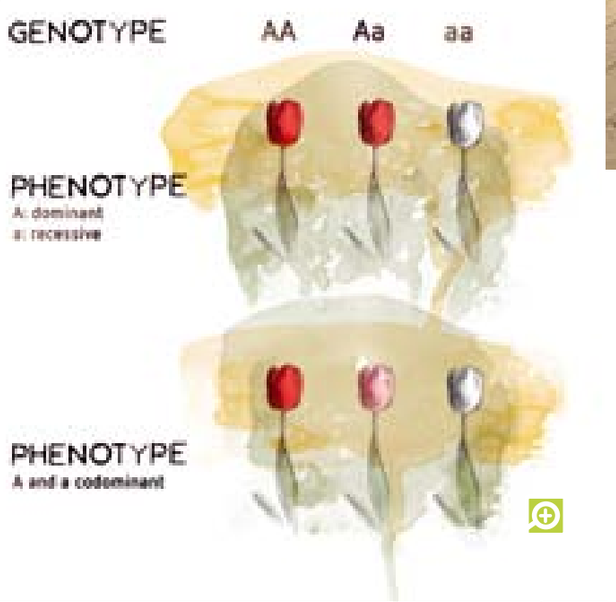


Figure 9: Genes exist in pairs in which one gene can be a dominant or recessive trait. Since these pairs work together, they can express in different ways.

What's HAPPENING

Roller derby is taking the world by storm. Again. Back from the 1950s, we would like to introduce to you a sport that has everything. Go derby! Go Clitty Clitty Bang Bang! Hello Olympic Games 2020! By Marco Barneveld, www.braindrain.nu

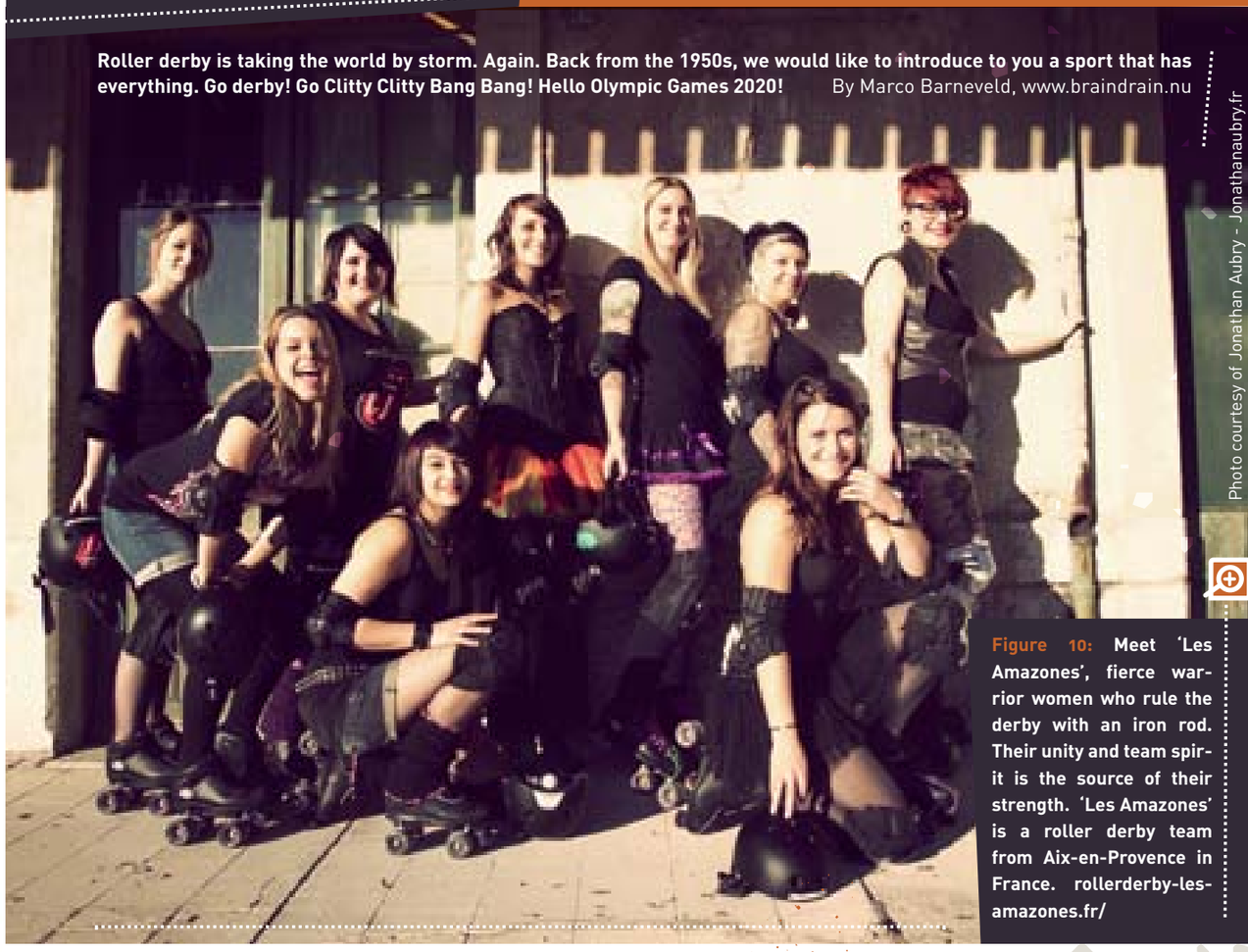


Photo courtesy of Jonathan Aubry - Jonathanaubry.fr

Figure 10: Meet 'Les Amazones', fierce warrior women who rule the derby with an iron rod. Their unity and team spirit is the source of their strength. 'Les Amazones' is a roller derby team from Aix-en-Provence in France. rollerderby-les-amazones.fr/

SKATE AND DESTROY

Girls on roller-skates. The words might well conjure up an image of lollipops, sweet sixteen and first kisses. But not a bit of it. Not when it comes to the type of girls on roller-skates we are talking about. This is roller derby!

Crushed noses

Think tattoos and stockings. Think mind-boggling speed, breath-taking manoeuvres, nose bleeds and fast, sometimes bloody action. Think of girls with names like Clitty Clitty Bang Bang, Michelle O'BamYa, Vulva Display or Power and Mazel Tov Cocktail. Welcome to the world of roller derby. Welcome to a sport that well could be the next sport sensation of this century.

But what is this, besides a sensational sport? What are the rules? Roller derby is a contact sport played by two teams

Photo courtesy of Dave Idemoto

of five members roller-skating in the same direction around a track. Game play consists of a series of short match-ups ("jams") in which both teams designate a scoring player (the "jammer"), who scores points by lapping members of the opposing team. The teams attempt to assist their own jammer whilst hindering the opposing jammer – in effect, playing both offense and defence simultaneously.

Spanksgiving

It's not just the names of the players that are outrageous. The names of the tournaments themselves are typically just as wild. For example, Night of the Rolling Dead (Night of the Living Dead), Are You There Blocker? It's Me, Jammer (Are You There God? It's Me, Margaret), Knocktoberfest (Oktoberfest), Spanksgiving (Thanksgiving), Seasons Beatings (Seasons Greetings), Grandma Got Run Over By a Rollergirl (Grandma Got Run Over by a Reindeer), Mama Said Knock You Down (Mama Said Knock You Out), Cinco de May-hem (Cinco de Mayo), and War of the Wheels (War of the Worlds).

It's viral

These girls on skates seem to be taking the world by storm, and a couple of the men in the audience too, to be honest. Derby is fast becoming the viral sport of this past decade. It may already have reached your town, as it has infected many towns in many countries across the world. In Rockland, Maine there is roller derby. In Austin, Texas, there is derby. Athletes skate in Berlin, London, Sydney, Brasília, Moscow, and Toronto. They skate in Lansing, Michigan, and in Moab, Utah.

Now, they say there's nothing new under the sun. The growing popularity of roller skating in the United States led to the formation of organised multi-day endurance races for cash prizes as early as the mid-1880s. Speed and endurance races were held on both flat and banked tracks in the first three decades of the 20th century and spectators enjoyed the thrill and spills - and the spectacular falls - of the skaters. The term 'derby' was being used to refer to such races by 1922.

Five million spectators

While the sport has its origins in the banked-track roller skating marathons of the 1930s, Leo Seltzer and Damon Runyon are credited with devising the initial competitive form of the sport. Professional roller derby quickly became popular: in 1940 more than five million spectators watched in about fifty US cities.

In 1948, Roller Derby debuted on New York television and the broadcasts increased spectator turnout for live events. For the 1949–1950 season, Seltzer formed the National Roller Derby League (NRDL). The NRDL consisted of six teams. NRDL season play-offs sold out in Madison Square Garden for a week. During the late 1950s and 1960s, the sport was broadcast on several networks, but attendance declined. Jerry Seltzer (Leo's son), the RollerJam "commissioner", hoped to use television to expand the live spectator base. He adapted the sport for television by developing scripted story lines, and rules designed to improve television appeal: but the derby's popularity continued to decline in spite of this.

Figure 11: The fight you see is The Hellcats and Putas del Fuego, which can happen after a player commits a Minor Penalty. When you are called for a Minor Penalty like pushing, unnecessary roughness, or tripping an opponent, you go to see the Penalty Mistress who spins the Penalty Wheel. There are a number of different options on the wheel including Pillow Fight, Tug-of-War, Arm Wrestle and Long Jump. These penalty face-offs are for a point loss so the person who committed the fowl is really trying to keep that point for their team. The Pillow Fight in particular has an element of audience participation – once the skaters have fought for 30 seconds, the audience screams for whoever they think 'won' the fight. There is also a panel of judges made up of members of the public who pay a fee to sit in what is called "Spank Alley" so they can judge the Pillow Fights. The panel of judges determines the final outcome of the fight. This can be pretty controversial because the judges are not always fair! Interested in watching a game? Please visit the Texas Roller Derby at txrd.com for more information .

Revival

Roller derby began its modern revival in the early 2000s as an all-female amateur sport organised by women. The revival initially began in Austin, Texas, and by August 2006 there were over 135 similar leagues. Leagues outside the US also began forming by 2006, and international competition soon followed. There are over 1,200 amateur leagues worldwide.

Whip it!

Each league typically features local teams in public bouts, which are popular with a diverse fan base. Larger venues hosting audiences of between 4,000 and 7,000 are no longer unusual.

Many leagues took advantage of the release of the roller derby movie, Whip It (2009), to increase awareness of the sport.

At the 123rd International Olympic Committee session in South Africa in February 2012, it was announced that roller derby was one of the eight sports under consideration for inclusion in the 2020 Olympic Games.

Burlesque

Derby is taking the world by storm and frankly, we understand. We are used to watching a bunch of men running around with a football or a soccer ball. We are used to guys wrestling and boxing. But sports are all about emotion and what stimulates the sensations more (since the bulk of sports lovers are guys) than a bunch of athletic chicks in fishnets calling each other sluts (it's only affectionate, they don't really mean it) and punching each other's lights out? On rolling skates! Some teams opt for a uniform or a livery; the camp can extend to players' garb as well. Costumes are often inspired by or comparable with rockabilly or burlesque fashions. And did we mention the stockings? We also understand why women love to take part and watch. It's these tough ladies fighting for their rights. Fighting for their honour. Throwing off all memory of lady-like behaviour. Hell, roller derby might well be the third-wave of feminism. A wave we embrace wholeheartedly, great sports lovers that we are. What we also love about derby is that it is an intelligent sport that combines skill, athletics, strength, endurance with strategy and plain old fun. What is there not to love? Go derby go! •

BRYCE CANYON

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

- The extraordinary rock formations in this photo are 'hoodoos' and you can find them in Bryce Canyon in Utah, the United States. The area, which is now a national park, was formed between 144 and 63 million years ago.
- The erosional forces of frost-wedging and rainwater has shaped the rocks into bizarre forms likes these spires. The red columns of rock consist of sand and calcium carbonate containing yellow and red iron compounds. Some hoodoos are sixty metres high and were formed between 66 and 40 million years ago.
- The rate of erosion in Bryce Canyon is between 2 and 4.3 feet every hundred years. The walls are made up of sixty different layers of sand, lime and shale. The colours of the rock formations vary from white and pastel pink right through to fiery orange and scarlet.
- Bryce Canyon is approximately 1.7 miles above sea level, making it cooler than lower-lying areas of Utah. Winters in the canyon can be very cold (down to minus thirty degrees centigrade) and most of the snowfall occurs from October to April. Average temperatures during summertime are about thirty degrees.
- Despite the name, Bryce Canyon is not strictly speaking a canyon, because its extraordinary landscape was not created by water and rainfall alone, but a combination of wind, water and ice erosion.
- In many rural areas of the United States, you can see 2,500 stars on a clear night. But in Bryce Canyon that number is as high as 7,500 stars can been seen twinkling in the sky.

Industrial activity and the combustion of fossil fuels generate a large amount of residue, much of which is released into the atmosphere. Some of this residue is highly toxic, and the rest can lead to the formation of oxidising or acidic substances that can cause physical damage and lower yields in cultivated crops. By Iñaki Garcia, CANNA Research

ATMOSPHERIC CONTAMINANTS

Volatile Organic Compounds (VOCs)

VOCs are organic substances that belong to the hydrocarbons group, which means that their molecules are formed by carbon and hydrogen. The carbon atoms unite with one another to form long branching chains that may contain other elements like halogens, oxygen, sulphur, phosphorus, silicon or nitrogen. VOCs generally are short-chain hydrocarbons that are volatile at room temperature, which is why some evaporate into the atmosphere.

Living organisms and human activity are both responsible for emitting these VOCs. Terpenes are an example of biologically generated VOCs that plants emit into the atmosphere and they are what makes plants smell. So, when we walk into our garden or through a forest and smell the perfume of a flower, this is because the plant is emitting VOCs into the atmosphere.

Nevertheless, most potentially toxic VOCs are produced by industrial activities such as the use of solvents or coatings and through the combustion of different hydrocarbons and gases. Examples of highly toxic VOCs are benzene and vinyl chloride, but there are others, ethylene for example, which at low concentrations can produce undesirable effects in cultivated plants.

In fact, we owe the discovery of ethylene as a plant hormone to the emission of VOCs. In the early 1900s, streets were illuminated with combustible gas lamps. With the passage of time, it was observed that trees located near these lamps lost their leaves. This led to the conclusion that products emanating from the lamps' combustion were responsible for defoliating the trees. Dimitry Neljubow, a Russian scientist, identified ethylene and acetylene as the substances responsible, which were produced in the combustion process. They affect vegetation in a range of ways, ageing leaves for example, and causing damping off in seedlings. In 1910, the researcher Coussin observed that plants also produce ethylene naturally, and to demonstrate, he exposed a container of plantains to the gases that emanated from a container of oranges: the ethylene made the plantains ripen faster. Today, the production of ethylene by plants and fruit is well-known, but we also now know that the production of ethylene by oranges is very low; this is why it was speculated in Coussin's experiment that the ethylene generated by the oranges was due to the presence of Penicillium fungus, which also emits this gas.

Ozone and other oxidants

Ozone is one of the strongest oxidants. The importance of the ozone layer located in the stratosphere is well-known. It absorbs a large portion of the high frequency ultraviolet rays in the stratosphere and prevents them from reaching the surface of the earth. Chlorofluorocarbons (CFCs) are VOCs that were used as a refrigerant and a propellant in aerosols, and which destroy ozone in the stratosphere. For this reason, its use has been restricted for several years.

However, when there is a high concentration of ozone in the lowest layers of the atmosphere closest to the surface of the earth, the gas can cause physiological problems in cultivated plants and health problems such as sore throats and asthma in other living things. An indirect effect of VOCs occurs when they combine with nitrogen, carbon monoxide and light, to produce ozone in a photochemical reaction. The emission of large quantities nitrogen oxide, mainly through the use of fossil fuel, promotes the formation of large quantities of ozone in the air around us close to the surface of the earth.

Ozone will penetrate plants, like all other ambient gases, through the stomata in plant stems and leaves. This causes various metabolic molecules to oxidise, which translates into necrosis or chlorosis of some parts of the plant.

Figure 12: Some nutrient deficiencies can also cause choloris and necrosis. In this picture, you can see leaves with an iron deficiency and this causes choloris: a pronounced yellowing of the leaves.

Figure 13: Example of plants with choloris.

Figure 14: Necrosis.

Various studies have shown that high concentrations of ozone will reduce the yields of certain cultivated plants that are particularly sensitive. Sensitivity to oxidation through ozone depends on the plant's own production of antioxidants. Treatment with an anti-oxidant substance like ascorbic acid (vitamin C) may be used when growing sensitive plants.

Peroxyacetylnitrate (PAN) is another oxidant compound formed through a photochemical reaction in the atmosphere. PANs will oxidise just as aggressively as ozone and can cause great damage to crops.

Sulphur oxides and acid rain

Sulphur dioxide and sulphur trioxide are not hydrocarbons since they are formed by oxygen and sulphur. But they are formed and released into the atmosphere through the combustion of petroleum and coal, which both contain large quantities of sulphur. In themselves, these chemicals cause respiratory problems in humans and also affect some crops. But when they combine with humidity in the atmosphere, they become sulphuric acid, which, when borne in raindrops, causes the well-known phenomenon of acid rain.

It is very important to avoid the use of chemical products like paint or solvents in greenhouses. These products generate large quantities of VOCs that can cause serious problems for cultivated plants, such as necrotic spots and chlorosis, not to mention a reduction in yields, or even the complete loss of your crops. •

Questions & Answers

We receive a lot of questions about growing. Of course, our researchers are more than happy to answer them!

Question

I grow tomatoes and eggplants in a commercial peat moss soil mix. Everything goes well until the flowers start to turn into fruits. The fruits crack from the bottom up and start to rot. I have also noticed that the foliage turns blue and purple and the leaves turn brown and dry out at the edges. Any ideas?

Answer

Your plants are suffering from an excess of some nutrients and a lack of others. The cracked fruits are reminiscent of blossom end rot which is caused by a lack of calcium. But the blue-purple leaves indicate too much potassium. The leaf margins burns can be the result of high salt levels in the soil. Start by checking the salinity and the pH of your soil mix. If the salts are too high and/or the pH is too low correct these values and the plants should start flowering normally again.

Question

I have heard that some types of paints can harm plants. Is this true and what can I do if I need to repaint my grow room?

Answer

Yes it is true, many construction materials including some paints release organic volatile compounds that can harm plant tissue and health. Ask your hardware store to sell you the lowest VOC (volatile organic compound) rated paint they can get. Mention that it is for a greenhouse. Many paint manufacturers offer such product lines. Once you have painted, let it dry very well before resuming gardening in there. That should prevent any damage to your plants.

Question

I'm using CANNA RHIZOTONIC and I was wondering how to use this product correctly. I am using a run-to-waste-system in which I water every day during the flowering period. How do I use your product? Do I use the RHIZOTONIC with every watering or should I apply the product once a week or every other watering?

Answer

CANNA RHIZOTONIC must be used every time that you water, together with the nutrients. The doses are mentioned in our grow schedule, but in short:
First substrate apply: 40 ml/10L
Veg. period at 18 hours: 20 ml/10L
Veg. period in 12 hours light cycle: 10 ml/10L
Gen. period (12 hours): 5 ml/10L

The reason you add less and less RHIZOTONIC is because the amount of root production is decreasing too. RHIZOTONIC will increase the pH. So it is better to prepare your tank and apply some of the nutrients already. Nutrients like Vega and Flores contain acid to lower the pH. After additives like RHIZOTONIC, you add the remaining nutrients that are needed to achieve your recommended EC. After the EC you correct the pH with pH minus.

Question

I am using CANNA Coco Slabs and I want to try to reuse them for a second crop. This is what I have done so far: I've removed all the old plants and also the biggest roots. I've flushed the slabs using a lot of CANNAZYM and purified water. After that I let the slabs alone for two days so the CANNAZYM could break down the old roots. But now I have some questions: 1) Have I done everything right? Have I forgotten anything? 2) I waited two weeks after my old crop was finished before removing the roots and flushing the slabs. Was this too long? I thought the slabs smelled slightly bad. Could there be mould or rot in the slabs now because of the two weeks without any watering or living plants in the slabs?

Answer

1) No, you did it right so far. But waiting two days to let CANNAZYM work is not long enough. The roots will not break down that quickly. The process takes more than two days. But the enzymes will already have started working.
2) Yes, you waited too long. Water that isn't refreshed will turn stagnant and start rotting (that is what caused the smell). Now you will have some mould or bacteria in the substrate. But don't worry, they aren't harmful. Just flush the slabs with water again. After harvesting you can start taking the roots out immediately and start cleaning. Then measure the EC in the Coco. If it is lower than 1.5, you have done your work fine. Now you can start to buffer it again with CANNA COGr Buffer Agent. If you work hard, the whole process can be completed in two days.

Question

A friend of mine and I have been arguing about oscillating fans. He prefers more air flow from many units. In my experience, too much horizontal air flow damages a lot of flow flowers and leaves and seems to restrict growth. Help us figure out who is right please!

Answer

You may both be right. We suspect your friend grows with higher relative humidity values than you do. When there is more moisture in the air, the plants prefer more horizontal air movement. It prevents the immediate air surrounding the leaves from saturating with water vapour and promotes transpiration. When the growing climate is dryer (below 50-55%), it is wise to reduce air flow as it can lead to desiccation. This will mean your plants cannot transpire correctly and they may suffer as a result. Another trick is to set your oscillation fans on a cycle timer to have them run for one minute and then stay off for five minutes, giving the foliage a pause from the strong winds.

Question

Does CANNACURE work against nematodes?

Answer

Nematodes generally live in the substrate so effective against them. Even if you give CANNACURE with the water solution (which we don't recommend) you won't get rid of them. CANNACURE is not toxic, it simply creates a sticky matrix. That's good news if you have nematodes like gnuts, but bad news if you wanted to kill negative nematodes. If harmful nematodes are the problem, there is only one solution: buy a new substrate and clean your pots, floor and system properly. Make sure that the nematodes cannot survive anywhere in your grow room.

Don & Nicky

(PART 2)

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

A tomato LOVE LESSON'

Is it possible to love your plants too much? I didn't used to think so. Last year several varieties of tomatoes decided, in unison, to teach me a love lesson. Even now I am left with an enduring image of two rows of tomatoes staring up at me from the ground – wilted, horrified and dejected. I loved these plants! What had I done so wrong? Had I loved them too much?

"You never know what is enough unless you know what is more than enough." ~ William Blake, Proverbs of Hell.

Looking back to the start of the growing season it's clear that I let my enthusiasm get the better of me. We'd just moved to the Mediterranean coast of France and had somehow managed to land a quarter acre kitchen garden right by the River Agly near Perpignan. The soil looked great and a plan was quickly hatched to festoon it with my favourite toms and other warm season crops – aubergines, sweet peppers, you name it – basically all the stuff I'd never got around to growing seriously in Britain due to a perennially absent greenhouse and, lest we forget, that wrist-slittingly awful British weather.

I busily raised dozens of tomato seedlings under some T5 fluorescents in my caravan -Cherry, Roma VF, Marmande, and some pear-shaped varieties. Before long all had received promotions to small pots and, then quickly after, up to three-litres. I moved them to a cold frame with some nocturnal heat mat action just to take the edge off those lingering chilly April nights. They grew fast – almost too fast – clearly loving their premium organic potting mix with mycorrhizae and perlite and, of course, regular irrigations from yours truly. Before long they were getting on for a foot tall, sometimes requiring two feeds a day, and were at risk of outgrowing the cold frame.

I watched the weather, eager to plant my toms out at the first opportunity as soon as nighttime temperatures were reliably above 14°C. It was still early in the season so, In an effort to keep them happy, I fed them with a little liquid organic feed to make up for their extended period of containerisation.

1 ..... 'I moved my tomatoes to a cold frame with some nocturnal heat mat action just to take the edge off those lingering chilly April nights'.

2 'First the toms looked super lush, but after a few days I saw that something went profoundly wrong'.

3 'Making large batches of sauce and ketchup with a seemingly endless supply of Romas!'.

The toms responded well to the feed so I stepped things up a little. They went crazy and looked super lush. I genuinely thought I'd be the envy of my gardening neighbours with these well-developed, vigorous and stout specimens! Finally, in mid May, planting day arrived.

It only took a few days to see that something had gone profoundly wrong. The foliage on all the varieties drooped, turned a pale green, and then became mottled and crispy dry. I was heartbroken. My wife was genuinely worried about me! I'd developed a strong bond with these young plants over the weeks and I'd expected them to explode with development once they'd been released from their five-litre prisons into the big wide world of the outdoor kitchen garden.

I told myself again and again that it couldn't be simply transplant shock. After all, I'd taken such care to acclimatise them and waited dutifully until nighttime temperatures were high enough. So what was wrong? All of a sudden the obvious fact hit me. I'd moved these relatively large plants from their mollycoddled world of containers, regular irrigations, premium potting mix and organic liquid feed to a completely underprepared field environment. I'd assumed that if the soil looked good, it was full of goodness. Big mistake! It turned out to be heavily depleted of nutrients (kitchen gardens are found vacant for a reason I guess!). Their compact root systems now had to fend for themselves in the real world, finding moisture and nutrients the hard way, requiring energy for the exploration!

My bedraggled plants snarled at me like spoilt, errant teenagers visiting for their first Sunday roast after being unceremoniously kicked out of home a few weeks before. It was tough on them, and me, and at one point I actually thought they were going to die. Unthinkable! I persevered though, coaxing them into their new environment with a little more liquid organic feed and homemade compost tea -organic goodness and the biology to break it down.

A week later something miraculous happened. It's as if the plants clicked into 'outside mode' and suddenly sprang back into life, tapping into the natural resources around them. New growth appeared and the plants quickly climbed up their supports. I dutifully picked off the suckers to focus the growth. Before long I was enjoying my first taste of cherry tomatoes and making large batches of sauce and ketchup with a seemingly endless supply of Romas.

Lessons learnt" Prepare your soil properly for hungry crops like tomatoes and don't grow them too big before transplanting"

MAKING TEMPERATURE WORK FOR SUCCESS

IF WE PUT TOGETHER EVERYTHING WE HAVE LEARNED SO FAR ABOUT TEMPERATURE AND PLANT GROWTH, ONE CLEAR MESSAGE SHOULD START TO APPEAR: TEMPERATURE HAS A DIRECT EFFECT ON THE GROWTH AND DEVELOPMENT OF A PLANT OR CROP. MOST INFLUENTIAL OF ALL IS AIR TEMPERATURE, WHICH CAN INFLUENCE THE ENTIRE PLANT SYSTEM. By Geary Coogler, BSc Horticulture

Figure 15: Each species of plant has a specific range of temperatures in which they can survive. These plants around the Tambopata river in the Peruvian Amazon like it best at an average temperature of 28°C, high relative humidity (over 75%) and a yearly rainfall of approximately 100 inches.

All the main areas of concern – watering, root zone, flowering, maturation, and harvest – are directly influenced by air temperature. Ambient air temperature serves as the main control of plant function and development. It can speed up or slow down all the chemical processes that need to happen for the plant to survive, and it can even affect the physical structure of the cells themselves.

But what about nutrition, and water, and all the other things that plants need? These are certainly every bit as

MAKING TEMPERATURE WORK FOR SUCCESS

important as temperature, but a plant will continue to grow, even if certain nutrients are lacking. As temperature is reduced, however, less growth will actually occur.

Temperature affects relative humidity which in turn drives the water supply and ion transport. Temperature will even affect the Phenotype of a plant. It will affect which ions are taken up, and it will affect the stability of compounds produced by the plant. It will also affect the incidence of disease and insect infestations. In short, temperature is important. It is the first thing you should check when you are looking for the cause of problems with your plants, and if success is important to you, temperature must be managed correctly.

Here are some important observations about air temperature:

1. The temperature of the inside of the plant tissue that enables photosynthesis to occur will be higher than the surrounding air. Light is focused and absorbed by the tissue, and some of it is converted into heat energy too.

2. Temperature, because it relates to humidity, determines both the evaporative potential for the plant and its need for water and so it drives the 'engine' of the plant.

3. Chemical reactions can all be regulated by the introduction – or removal – of heat: in plants, the higher the temperature, the faster chemical and physical reactions occur, up to the point at which the reaction chain is short-circuited.

4. Temperature affects the shapes of some molecules, particularly proteins, and both higher and lower temperatures will 'denature' a protein which means it changes shape and becomes different. Think about what happens when you boil an egg, for example.

5. Temperature has an ideal range, and it also has a survival range.

6. Air temperature should be adjusted with root zone temperature in mind. When root zone temperatures are too far below air temperature, the root system may fall behind the top of the plant, meaning a lack of water and nutrient uptake.

7. Because temperature affects the production or utilisation of many compounds within the plant, it can be used to control many factors such as height, the intensity of colours, or even metabolite production.

The temperature of the growing environment must be regulated whenever possible, and mitigated when this is not possible. Methods of regulating air temperature can vary and how this is done matters little, as long as factors such as safety and humidity are planned for. There are forced air systems, evaporative cooling systems, radiant heat systems, steam, hot water, electric, and so on. However, looking at all these different systems is not our concern here, but rather why we should regulate temperature and what we can achieve by this.

The entire discussion about temperature could probably be condensed down into the notion that a plant is basically a water-filled collection of very small bags (cells) in which chemical processes occur, and that temperature defines the boundaries within which these reactions can occur as they should. These chemical processes are, essentially, what life is – the succession of reactions that occur beginning from the translation of DNA to the accumulation of mass through self-replication. The ultimate goal is to ensure that all the chemical processes occurring in the proper order, at the proper time, and at maximum capacity, just like any other assembly line out there. The closer the conditions are to 'perfect', the better these processes will occur.

Figure 16: Environmental factors determine the development of the plant. These factors are also interrelated, and the most dominant of all is temperature.

Although plants share a majority of the same processes, they do differ in their ultimate composition based, in large part, on the environment in which they have evolved, so it is not a one-size-fits-all situation. Any plant will have a temperature range in which it does best, as well as substrate conditions, light quantity, light quality, and water availability, and all these things affect whether the chemical processes that constitute life can occur as they should. These temperature ranges correspond to the range within which water remains liquid. Each species of plant has a specific range of temperatures that they can survive in. They also have a much smaller range within which they will perform optimally.

Because all the essential factors for plant life (light, temperature, water, element availability) are interconnected, and because the plant depends on accumulating certain components needed for these processes before they can begin others, they develop cycles of minimum and maximum activity known as diurnal cycles, or daily cycles. Everything needs to come together at the correct time within a 24-hour window.
All this involves the many effects of temperature including its direct effect on humidity. As air temperature rises or falls, so too does its capacity to hold water. This is why we talk of Relative Humidity – the level of humidity in the air is always relative to what the temperature is at any given moment in time. The humidity content in the air governs the rate at which evapotranspiration can occur in a plant. This is the process that cools the plant tissues in which the chemical processes occur, supplies the water that the plant needs, and includes nutrient transport in a process known as mass, or bulk flow. These chemical reactions not only require a certain temperature, they also give off heat themselves. In addition, the temperature at which reactions will occur effectively controls what the plant produces and how well it works.

If a grower is aware of these relationships, he can also calculate what temperature ranges the crops need and provide this on the basis of the stage at which the crop is in, taking into account all the other requirements such as light levels, timing and intensity and quality. If the grower cannot regulate these temperatures, he must adjust the other aspects of growing, again such as light levels, water supply, humidity, and fertility based on the temperature conditions that will affect the crop.

The grower can also control the temperature to achieve a certain level of growth or development. One of the best ways to use temperature controls is to regulate the difference between day and night temperatures. The DIF is the difference between day temperatures and night temperatures. This influences growth and development benchmarks such as internode length (plant height), leaf and shoot orientation, chlorophyll content, branching and flower development. Some plants delay flowering if the day temperature is lower than the night temperature (negative DIF), but they will develop height faster through internode elongation. Cooler night temperatures can control flower development and colour, maintain a compact growth form, and influence the development of plant specific compounds. The grower should research the crop being grown because all plants react differently – there are not only differences between species but also between varieties of the same species.

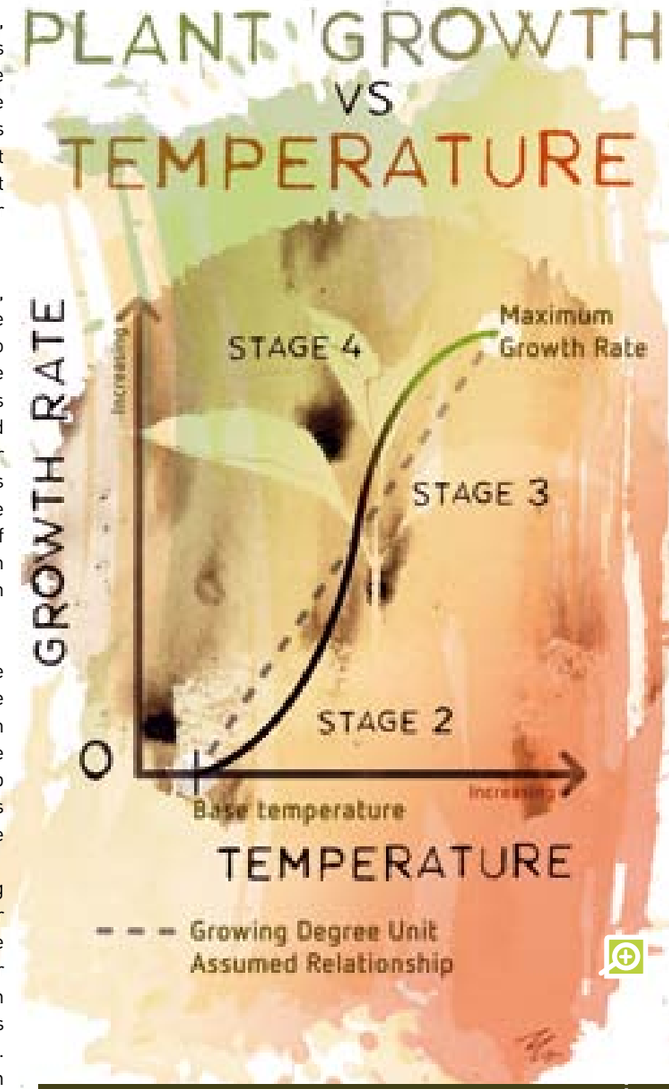


Figure 17: Temperature range affects growth rate: from the low end, where growth is very slow, climbing rapidly as temperature increases to a plateau where temperatures that are too high also inhibit growth.

MAKING TEMPERATURE WORK FOR SUCCESS

Temperature will also affect what is possible and how the plant or crop should be fed and watered. Where day temperatures are higher or lower than the optimum range, the water supply and feed applications should also change. Higher temperatures and brighter light levels will soon require higher amounts of water while nutrient concentration should be reduced because the plant needs more water. Of course, as mentioned earlier, the same can occur when the humidity levels are out of line with the temperatures.

Typically, during the flowering stage, night temperatures should be cooler than day, but this can vary from plant to plant. Just a few degrees can make a difference in the timing and final quality of the crop. Additional techniques for using this knowledge of differences in temperature (coupled with light quality/ quantity) are known but have not been tried and tested to the same extent in real-world growing. Even a short duration 'dip' in night temperature can produce results. While a small difference is allowed between night and day temperatures, an additional couple of hours in which the temperature dips further right at the beginning of daylight conditions is allowed. This is hard to achieve with current controller design but shows some promise.

In the end, the grower has to understand the needs of his crop, what is possible for that crop and cultivation set-up, and he must provide a minimum level of regulation to achieve consistent quality. There are no short-cuts here. The plant develops within a certain temperature range. While the plant can survive and even do moderately well in a wide range of air temperatures, optimum performance is impossible without the optimum temperature range. •

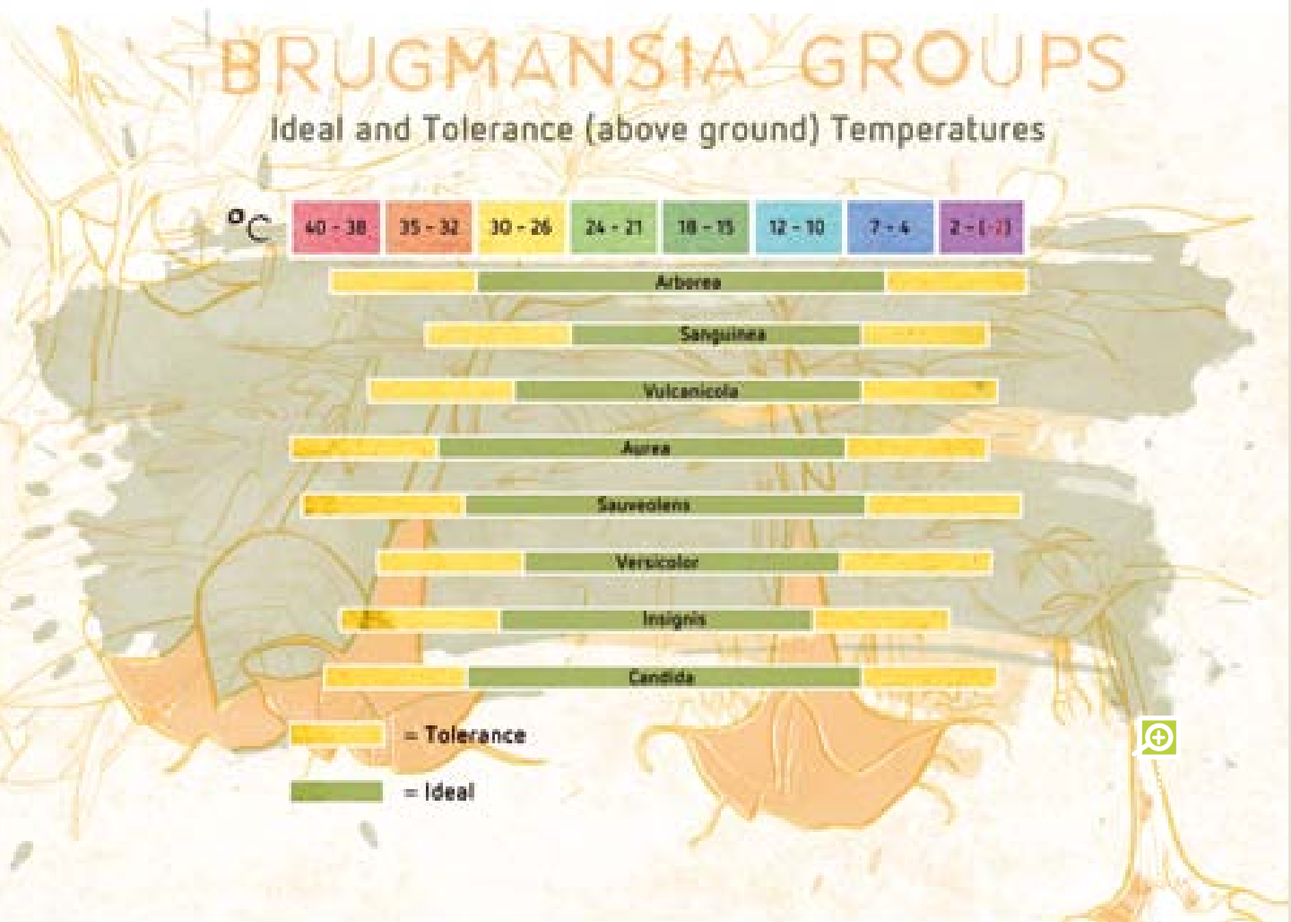


Figure 18: Every plant has a temperature range that it can tolerate and a range it does best in. Even closely related plants can have specific ranges of their own.

Grower's TIP #21

By F.F.

TEMPERATURE IN THE INDOOR GROW ROOM

As described in previous articles, temperature of the grow room influences plant health and crop growth performance. Growing indoors requires the use of climate conditioning equipment (such as air conditioners, exhaust fans, evaporative coolers, etc.) which if properly sized, installed and controlled will regulate the temperature of the grow room. Unfortunately, no set-up is perfect. Here are a few things to consider.

GARDENS USING FORCED AIR VENTILATIONS AS MEANS OF COOLING

The use of exhaust and intake fans to regulate temperature is only efficient if outdoor temperature is significantly lower than regular daytime grow room temperatures. This cooling equipment should be equipped with backdraft dampeners to inhibit any chimney effects (passive air exchange) when fans are not running. If the ducting circuit is open when fans are off, cold air finds its way into the garden, usually over cooling the night time air and grow mediums. This is especially true for wet mediums and can induce serious plant issues.

GARDENS USING AIR CONDITIONERS AS MEANS OF COOLING

Air conditioners are usually very efficient in removing heat and moisture from the garden. But when the lights turn off they usually stop conditioning. This means that no dehumidifying is going on. This is easily solved by adding independent dehumidifiers. Even though dehumidifiers produce heat, additional heaters may be needed. Also most ACs can be fitted with a heating element. Also CO_2 levels have to be replenished if too little air exchange is done daily.

GARDENS USING EVAPORATIVE COOLERS AS MEANS OF COOLING

This equipment is efficient only if the outside air is very dry. Above 30% relative humidity, the cooling dims significantly but the evaporative cooler can still help raise relative humidity levels. On rainy days (outdoor air is very moist) this equipment cannot properly cool down the indoor grow room. High temperature automatic light shut-offs should be installed to prevent heat damage.

Gardens using recirculating systems such as ebb & flow

The reservoir containing the feed solution should rest on some insulation material (such as Styrofoam) to shield heat loss from contact with the floor. A water heater element and thermostat can also maintain the reservoirs temperature. In hot garden condition a water cooler may be needed to reduce its temperature.

Finally using a minimum/maximum thermometer can help pinpoint any temperature extremes in the garden. Even better is using a USB data logger to record values through a few days.

Puzzle&WIN

Was the sudoku we gave you last time too difficult? Maybe you'll find this wordsearch a bit easier. If you've never done a wordsearch before, here's what to do.
The words in the list below can all be found in the wordsearch. Draw a line through the words in the puzzle (horizontally, vertically, diagonally, forwards, backwards). The remaining letters will spell a secret message which is the solution to the puzzle.

Great PRIZES

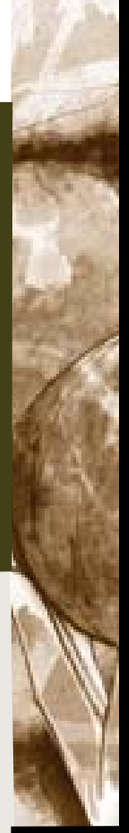
WORD SEARCH

S	S	I	O	R	A	N	G	E	S	R	A	T	S	C
I	D	E	Y	R	U	T	N	E	C	P	E	V	H	S
S	S	N	N	I	G	R	A	I	E	M	O	E	O	E
E	D	G	S	S	E	A	T	M	P	C	M	R	K	L
H	E	I	N	D	A	E	N	E	O	I	Y	E	T	U
T	V	N	I	I	L	T	R	I	C	T	D	R	O	R
N	E	E	E	H	L	A	I	A	S	R	S	E	B	A
Y	L	A	T	G	T	D	L	O	O	M	O	H	E	I
S	O	A	O	U	O	D	E	A	N	S	S	P	R	N
O	P	G	R	O	W	T	H	E	N	N	J	S	F	W
T	M	E	P	O	B	L	I	S	S	O	F	O	E	A
O	E	N	E	G	O	R	D	Y	H	W	I	M	S	T
H	N	S	E	L	U	C	E	L	O	M	■	T	T	E
P	T	E	N	E	L	Y	H	T	E	■	■	A	A	R
T	N	A	L	P	S	E	I	T	F	I	F	■	■	N

ATHLETIC
ATMOSPHERE
BRYCE
CENTURY
CHEMICAL
CROP
DEVELOPMENT
ENGINE
ETHYLENE
FIFTIES
FOSSIL
GROWTH
HYDROGEN
MOLECULES
NATIONAL
OKTOBERFEST
ORANGES
ORGANISMS
PHOTOSYNTHESIS
PLANT
PROTEINS
RAINWATER
RED
RULES
SEEDLINGS
SENSATION
SNOW
SPORT
STARS
STOMATA
TEMPERATURE
VOC

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 CANNABOOST!



WHAT'S NEXT

These days, high-quality horticultural coco is recognized as a superior growth media for soil-less crops. In the next edition of CANNAtalk you can read how to use coco and how to solve your growing problems.
It will also be the third time for our 'new' items Genetics & Breeding and Don & Nicky. In Genetics & Breeding, one of our researchers will explain all you need to know about day-neutral plants. And we can't wait to hear about the latest adventures of Don & Nicky.
Interested in all this, plus how to grow your own passion fruit? Then don't miss 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

- ☐ AQUA Fertilisers (Recirculating systems)
- ☐ HYDRO Fertilisers (Run to waste systems)
- ☐ COCO Fertilisers (Coco Coir)
- ☐ TERRA Fertilisers (potting mix)
- ☐ Additives (Optimizing your yields)
- ☐ 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:

#21

CANNAtalk

SERIOUS GROWERS

CANNAtalk:

- Is published by CANNA BV, a company dedicated to finding the best solutions for growth and bloom.
- Is distributed through local UK retailers and wholesalers.

Editor: Karin Brinkman
E-mail: info@CANNAtalk.com
Phone UK office: 0870 240 2991
Printed by: Koninklijke Drukkerij E.M. De Jong

CANNAtalk doesn't just write about nature, it is also committed to preserving our natural environment. Did you know, for example, that this paper comes from sustainably managed forests? And that your favourite magazine is printed in a carbon-neutral printworks?

THIS PRODUCT IS PRINTED AT A CARBON NEUTRAL COMPANY

MIX Paper from responsible sources FSC® C019223

YOUR ADDRESS

We will refund your postage cost

Name

Address:

Email:

put this card into an envelop before you send it

CANNAtalk IS your magazine, YOUR VOTE COUNTS!

#21