

# In Greenhouses

The independent international magazine for greenhouse growers



## Hydroponic lettuce grower has most modern technology

Number 2  
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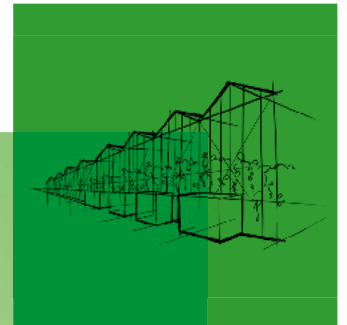
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Little Leaf Farms is a semi-closed greenhouse in the United States. They grow fresh lettuce all year round as a greenhouse hydroponic company based on the most modern technology that is revolutionizing the lettuce market (page 15).

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**PHILIPS**

Horticulture

# Discover my recipe for growth.

Roelf Schreuder  
New Zealand Gourmet

“At Gourmet Mokai we want to grow and sell a sustainable product that stands out in quality, taste and shelf life. Though we could produce some tomatoes in winter using natural light, we were not able to keep up when customer demand rose. We sought a lighting provider with a lot of experience, and Philips had the most advanced techniques and knowledge to support us. We installed a combination of Philips GreenPower LED toplighting and Philips GreenPower LED interlighting on 4,500 m<sup>2</sup> of our tomato greenhouses and worked intensively with the Philips plant specialist. We now have a more predictable yield in wintertime and a more stable supply throughout the year. **We’ve switched on growth.**”

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HENK VAN ESCH  
INTERIM EDITOR-IN-CHIEF

# It will take years to recover from this crisis

We're living in extreme times right now. Who would have thought that we would find ourselves in the midst of a global pandemic in 2020? The coronavirus has spread all over the world and has already claimed many thousands of victims, and it will be a while yet before we are rid of this dreadful disease. No-one knows when this miserable time will end.

Apart from the vast numbers of victims, the coronavirus is having other very nasty consequences. The international trade in vegetable products and, in particular, ornamentals has largely collapsed or even come to a complete standstill. In this issue, we talk to nursery manager Nick Radcliffe Stevens of Fairweather's, one of Europe's major suppliers of agapanthus and lavender, who says: "It will take us years to recover from this crisis." (see page 6).

Every business owner is currently working hard to keep their employees safe, but businesses are also having to do what they can to survive. A good many will no doubt come through this, but there will be a lot of economic casualties. And it is likely to be many months or perhaps even years before we emerge from this crisis. But as the saying goes: "This too shall pass".

Things will eventually start coming right and growers in the world's protected horticulture sector will be able to start selling their products normally again. So despite the difficulties we are facing today, it is important that they continue to focus on producing a high-quality product. And that will mean keeping their technical and horticultural knowledge up to date. As ever, in this issue of In Greenhouses we're doing our bit. This time we shine the spotlight on fertilisation, and we also look at a range of other subjects from energy saving, substrate, greenhouse construction, screening and irrigation to pests and diseases. After all, knowledge is the basis of expertise.

'Fertilisation is an ancient discipline, but many growers still find it tricky'

*PS: The next issue of In Greenhouses will be published in July 2020.*

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## In Greenhouses

The international magazine for greenhouse growers

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Nick Radcliffe Stevens: "The invest in LED lights last year enables us to deliver an additional 250,000 young plants on an annual basis, agapanthus in particular."

Added value through high quality and extensive range of plants

## 'It will take us years to recover from this crisis'

**Fairweather's is one of Europe major suppliers of agapanthus and lavender. The nursery offers distinctive added value through high quality and an extensive range of plants. The company has expanded considerably in recent years and has invested in LED lights in its greenhouses. However, the coronavirus crisis has forced them to put further plans on hold.**

2020 was set to become a top year for Fairweather's Wholesale Nursery in Beaulieu in the county of Hampshire in the south of

England. At least, that was the expectation. "Over the past years our production has risen by around 15% a year," says nursery manager Nick Radcliffe Stevens. "A big factor was the increase in our export volumes. In 2018 and 2019 we even achieved record turnovers and were keen to continue that trend in 2020. But coronavirus has put a stop to those ambitions."

Coronavirus has had a major impact on the company, which supplies the majority of its plants in spring and therefore relies on this period to realise 60-70% of its turnover. "These are certainly tough times; many orders are being cancelled. Our only advantage is

that we also supply to garden centres online, so those activities are still going on. Now that people are being forced to spend more time at home, creating a nice garden is one of the few things they can do."

The effects of coronavirus have reduced the workforce at the nursery to four. "The other eight team members are at home. Fortunately, the government is offering businesses grants worth up to 80% of the wages."

### Focus on agapanthus

The history of the company goes back nearly sixty years. The company was founded in

Continued  
on page 8 >



**Today agapanthus is the nursery's main product.**

1961 by the father of owner Patrick Fairweather. Initially, plants were propagated for delivery to garden centres, but after a while the focus shifted to propagating and growing young plants. Today agapanthus is the nursery's main product. "Over the last decade we became a recognised agapanthus specialist and now

supply over fifty different cultivars of this plant. Of the one and a half million young plants we deliver each year, about fifty percent are agapanthus," says Radcliffe Stevens.

This activity received an important boost when he acquired a collection from another grower a few years ago. They also cooperate with various breeders. "We propagate tissue culture plants from the laboratory, which we supply in plugs or in P9 pots. These plants are kept in the greenhouse for the first few weeks – we have two different greenhouses – before they are moved outside. There we have some large container fields."

Raising the plug plants takes eight to sixteen weeks, but it takes another three to eight months to deliver a plant in P9. The precise period depends on the season.

Another important activity at the nursery is supplying young lavender plants. Lavender makes up about 25% of the turnover. "We also supply a wide range of other perennials, shrubs and climbers such as campanula, dahlia, euphorbia, hosta and lobelia."

### Continuous monitoring

Fairweather's mainly supplies to other growers. They grow and sell the young plants to garden centres and other outlets. The nursery delivers to growers in the United Kingdom, but also

exports to countries like Spain, Italy, France and Germany. "Around 30% of our plants are shipped abroad. In addition, wholesale supplies to online garden centres are an important sales channel; in the UK, for example, the Crocus webshop is a key customer. We also supply agapanthus in 2.5 litre pots directly to garden centres."

According to Radcliffe Stevens, a major contributing factor in the increase in production in recent years is the fact that he offers a wide range and guarantees good quality. "Our priority is delivering plants with a well-developed root system, and we continuously monitor the plants for pests and diseases. We also ensure that the plants are delivered weed-free."

### New gall midge

The latter aspect in particular, according to Radcliffe Stevens, is becoming big issue due to the rapidly decreasing number of approved herbicides. "And because the number of herbicides is so limited, there is a high risk of resistance. We now do experiments with applying a layer of mulch to the pots to suppress weeds. But that's no easy task in the small P9 pots."

Another problem is a new species of Cecidomyiidae – or gall midge – which was



**The company propagate culture plants from the laboratory. These plants are kept in the different greenhouses for the first few weeks before they are moved to some large container fields outside.**



**Fairweather's also grows a lot of lavender, perennials, campanula, dahlia, euphorbia, hosta and lobelia.**

first seen in the United Kingdom a few years ago. This insect attacks the flowers on agapanthus. "There is still no effective method to control this pest. We hang up yellow sticky traps to catch the midges and are investigating the options for biological pest control. Another thing we do is remove the flower buds weekly. We want to make absolutely certain that the plants we deliver are free of this gall midge. But these control measures take up a lot of extra effort."

### Ideal LED-spectrum

Although Fairweather's has not invested more in expanding the surface area of the nursery in recent years – the increased production was mainly achieved by optimising the use of the available space – it did invest in LED lights last year. "We already had LED lights in one of our two greenhouses, but we wanted to equip the second greenhouse with the same system. Previously we had to stop weaning tissue culture plants from week 40, but now we can continue throughout the winter. This enables us to deliver an additional 250,000 young plants on an annual basis, agapanthus in particular. Another great advantage is that it allows us to retain more members of the team on a year-round basis."

In order to create the ideal light spectrum and intensity, various trials were done, in consultation with supplier Indo Lighting. "During eight weeks we examined the impact of four different spectra with blue and purple light, with a particular emphasis on the effect

of light on root development. That is a really important aspect for the growers who buy our plants. The spectrum we have chosen contains a lot of purple light."

### On hold

What does the future hold for the nursery? Are there any plans? "We had some pretty ambitious plans: further expansion, intensifying our grass propagation activities, and so on, but the coronavirus crisis has put all of that on hold. We are all in the dark as to what lies ahead. We just have to review the situation day by day. I am not worried about our chances of surviving this crisis; we are fortunate enough to have had some very good years behind us. But it will probably take us several years to recover and achieve the same level as before."

## Summary

Fairweather's specialises in supplying young agapanthus and lavender plants. The plants are supplied to growers in the UK and several countries in mainland Europe. Production has increased significantly in recent years, partly thanks to investments in LED lights. Due to the coronavirus crisis, future plans have been put on hold for the time being.



## Change

Before starting a new season you try to anticipate the coming season as much as possible. We have taken steps to prevent TYLCV (Tomato Yellow Leaf Curl Virus) and have spread the sales risk by growing pink beef and cluster tomatoes. It will be a learning year, providing us with a lot of data which will enable us to make good choices for the future. Turns out we were in for some surprises this season, though. Management has decided to go down a different path in terms of how to run a greenhouse. My wife and I have decided not to extend our contract.

Then the coronavirus outbreak began. Because we produce food we are allowed to continue to operate. I see a lot of flower and herb growers losing all their yields. My heart goes out to them – what a disaster. We are stuck in Azerbaijan with no possibility of travelling for the time being. What about our family? My daughter works in Malta and my son lives in Tilburg where the coronavirus first emerged in the Netherlands. My mother is 80. This season has been nothing like we expected it to be. We are keeping in close touch with our family and friends on Skype. There's no other option than to stay calm and accept the situation. We are keeping to the strict regulations issued by the government and we are avoiding contact with others as much as possible. The last thing you want is to end up in a local hospital.

We all have a different point of view during this Covid-19 crisis. Europe is facing its biggest challenge since the Second World War. Some will see their life's work destroyed, while others will profit. Problems around education will be solved differently and working from home has proven effective.

I am sure the professions of nurse, refuse collector and farmer will be acknowledged and appreciated for a short period of time. History shows that us it takes a disaster to force change.

Let's just hope the sacrifices people are making will result in a more social world where money and materialism become less important.

John van der Lee  
Tomato grower in Azerbaijan

All plant organs pull as hard as they can for available sugars

## Distribution of assimilates can be steered

**The distribution of assimilates within a plant is difficult to steer with temperature, light and CO<sub>2</sub>. Crop yield is dependent on the total amount of assimilates and how much of these go to the useful parts of the plant. The smaller the part of the plant harvested, the more important it is that the sugars reach the right place. Picking young leaves on fruit vegetables can lead to better distribution.**

The distribution issue is most important for fruit vegetables. Just one part of the plant – the fruit – is harvested and it's the reason why most research in this area is carried on these species.

Much less has been done on cut flowers. Here you harvest a larger part of the plant, not just the flower but also the stem and leaves. There's a large difference between

species. For example, almost the entire chrysanthemum plant is harvested while for gerberas it is a relatively small part. This makes it possible to make improvements in gerbera, primarily by stimulating the formation of more flower stems.

In pot plants the question of sugar distribution is somewhat different. One hundred per cent of the product is harvested but still the distribution of sugars plays a role in the visual appearance.

### Fixed distribution

Various research on tomatoes shows that approximately two thirds of the assimilates go to the fruits. This is quite a lot. In cucumbers it's about the same. In sweet peppers it's a little less although a large increase in production could be achieved in this crop through better distribution of the assimilates. To ensure more assimilates reach the peppers

more fruits have to remain on the plant: Now about two thirds of the flowers abort.

It is also been shown that in the first year of a rose crop two thirds of the total growth is in the part of the product that is harvested (flower + stem and leaves).

It's noteworthy that this distribution within the plant has a fixed percentage. With an optimally fruiting tomato plant it's always two thirds (up to 72 %) that reach the fruits. Light, temperature and carbon dioxide have no effect on the principle of distribution (see below).

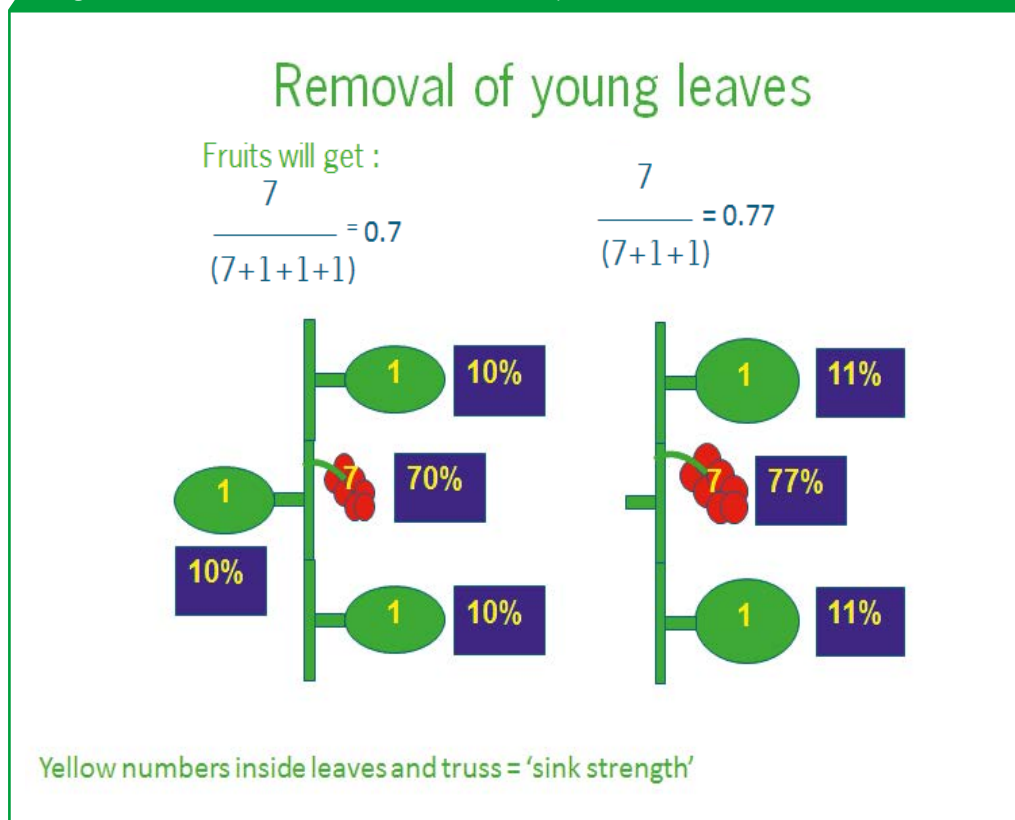
Of course, more light or a higher CO<sub>2</sub>-concentration can result in a better setting and consequently relatively more sugars in the fruits. But this is an indirect effect on distribution. A direct effect is also possible, by intervening in the plant itself by means of pruning.

### Sink strength

To understand how this can occur it's first necessary to have some theoretical knowledge about plants. The principle behind the division of assimilates is the so-called sink strength. All organs in the plant work as a sink, drawing sugars towards them. The sinks don't all have the same strength. Fruits pull the most, especially the fruits that are about half way through their development. Young apices and flowers also draw on sugars while old leaves hardly have any pull at all.

The sink strength of such an organ (leaf, flower, fruit) is the maximum growth achieved per day if there was no competition. But the competition within the plant is very strong. All organs pull as hard as they can for the available sugars: The more they pull the more they get. So organs with a larger sink strength always obtain more than those with a smaller sink strength. For example, a truss of tomatoes with a sink strength of three receives three times as many sugars than a leaf with a sink strength of one. The ratio remains the same whether there are more or less sugars available.

Figure. Distribution of assimilates within a plant



**On a plant with three young leaves and one truss, 70% of the sugars are drawn to the truss. Each leaf receives 10%. If one of the three young leaves is removed 77% of the assimilates reach the truss. The numbers 1 and 7 (in the leaf and in the truss) represent the sink strength.**

### Remove young leaves

Based on this principle you can make use of a method that hardly occurs in practise.



**The removal of young leaves results in higher production, providing the plant has a large enough total leaf surface area.**

A greenhouse experiment and a simulation study at Wageningen University examined the effect of removing young leaves from the top of the tomato plant. The researcher removed young leaves, of maximum 3 cm, to increase the flow of sugars to the fruits. The *figure* shows how this works. The truss of tomatoes and the young leaves, each with their own sink strength, pull on the sugar supply. In the example, the truss has a sink strength of seven, the leaves each have one. If we assume this is a simple plant with three young leaves and one truss, 70 per cent of the sugars end up at the truss. The leaves barely get 10 per cent each. If one of the three young leaves is removed more sugars, 77 per cent, end up at the truss. The remaining leaves also obtain more but due to the difference in sink strength the truss receives relatively more.

Therefore this can be a method of steering more sugars to the fruits, and not just in tomatoes. It doesn't work if you remove old leaves because these are already fully grown and hardly draw any sugars towards them.

However, two remarks should be made. Firstly, the removal of leaves that are just 3 cm is difficult. Removal of slightly bigger leaves also has the desired effect but the leaf has to be 50 per cent less than its final length. The second remark: The removal of leaves

affects the assimilation system. Sufficient leaves have to remain on the plant. In other words, the leaf area index (the number of square metres of leaf surface area per square metre of ground surface area) has to maintain a certain value. That means that when removing young leaves you should remove fewer older leaves to maintain the leaf area index. Incidentally, another option is to maintain a higher stem density as this also increases the number of square metres of leaf area per surface area of ground.

### Higher production

The first impression is that it's mad to remove young leaves. But the model calculations show that it works. When one in every six young leaves was removed production increased by three per cent. When one in two leaves was removed (so a drastic measure) production increased by ten per cent. Once again attention was paid to ensure that the total assimilation capacity remained in balance.

In the greenhouse experiment the middle one of three young leaves was removed. This resulted in a clear increase in production.

The disadvantage of this system is the extra work. But it's not so bad if it is combined with pinching out. Some (cherry) tomato growers are applying this method.

### Distribution

These results were presented at a meeting of breeders who found the results very interesting. It might be possible to reduce the number of leaves between trusses through breeding. Then more sugars will go to the fruits.

There are some tomato species varieties that have just two leaves between the trusses instead of three. If these properties could be crossed into a commercial variety it could increase production. However, in plants in the wild this characteristic is coupled to other negative characteristics. With modern breeding techniques it might be possible to find a way around it.

## Summary

To achieve high production, especially in fruit vegetables, it's important that as many of the assimilates as possible reach the fruits. During research the removal of every one in two young leaves resulted in ten per cent higher production. However, the number of squares metres of leaf to square metres of ground area has to remain in balance.

Research project: The Chrysanthemum In Bloom

# Saving on light almost impossible without sacrificing quality



The differences in plant density clearly show the variations in production of side shoots. A: 17 stems per  $m^2$ , B: 35 stems per  $m^2$ , C: 52 stems per  $m^2$ , D: 70 stems per  $m^2$ .

**The spray chrysanthemum has an enormous appetite for assimilates. So say researchers who have put this cut flower under the microscope in their quest for the perfect climate conditions for growth, kilograms, transpiration and colour in all seasons with different plant densities and cropping durations. Their conclusion: saving on light is almost impossible without sacrificing quality.**

It was meticulous work. Four days a week for ten weeks, two people took measurements across the trial section in the greenhouse, cutting off parts of plants and carefully collecting leaves, stems and buds. All the plant organs were then weighed, put in the drying oven and weighed again to measure the biomass. And that was only one part of

the trial. "I said so right from the start," says Sander Hogewoning of Plant Lighting who is supervising the trial together with his colleague Stefan van den Boogaard. "This trial will take time and patience."

### Balance between source and sink

One of the complex issues was the fact that the chrysanthemum undergoes determinate growth. That means that demand for assimilates varies at different stages of growth. The plant needs far more sugars in one growth stage than in another, and this demand for sugars (sink) is not necessarily in balance with the production of sugars via photosynthesis (source).

"It's easier with plants with indeterminate growth, such as cluster tomatoes," Hogewoning says. "Whenever a cluster is removed, a new one is formed. The demand for assimilates is

in balance. It doesn't work that way with the chrysanthemum. You start with a cutting which roots, then young leaves grow and a bud forms, and then growth slows down for a while. We expected the demand for assimilates to be lower at that stage, at around day 40 after planting. Then the plant starts producing side shoots, so the demand for assimilates shoots up again. The balance between source and sink therefore varies."

Hogewoning and the partners involved wanted to answer several questions: When demand for assimilates is low and the plant therefore has sugars left over, is there scope for saving energy? Could the grower turn down the lighting at that point? And what does the plant do with the sugars it has left over? Are they stored as reserves, and if so, whereabouts in the plant, and are they available if the plant needs them at a later stage?

## Striking plant weight

Van den Boogaart immersed himself in the greenhouse at Botany, where they had set up twenty trial sections with two varieties of spray chrysanthemums, Bacardi and Baltica, with five different plant densities and at two temperatures (18 and 22°C). He put his skills to work there, mapping out the plants' photosynthesis by carrying out measurements at different plant heights and at different stages of growth. He also looked at how the leaves responded to factors such as the greenhouse climate, CO<sub>2</sub> and light. "A lower plant density seemed not to impact on the use of light for photosynthesis," he says. "That is an indication that the plant can still use its sugars relatively effectively for growth."

Another striking factor was plant weight. At a low plant density, a Baltica stem grew to as much as 295 grams, way more than the usual 80 to 100 grams. The distance between plants turned out to have a huge impact on plant weight, with plant investment in flowers increasing most. Temperature had little impact on plant weight.

The low plant density also resulted in the plants starting to develop side shoots at a much earlier stage. Plants with 17 stems per m<sup>2</sup> started to grow side shoots after just 20 days, for example. The side shoots with developing flowers were the main reason for the massive growth in plant weight.

## Different plant densities

The researchers conducted a second trial in parallel, in which the plants were grown in pots in different plant densities for forty days and were then transferred to a greenhouse at a density of 52 stems per m<sup>2</sup>. "We expected the plants coming from a low density to have spare carbohydrate reserves by about day 40," Van den Boogaart says. "So we measured the amount of carbohydrates stored in the different plant densities."

Plants contain various types of carbohydrates. The researchers looked at the complex carbohydrates fructan and starch. "These are the storage reserves. We discovered that these reserves are mainly held in the centre of the stem and in the young, fully-grown leaves at the top of the plant."

## Less lighting impacts on quality

Interestingly, these storage reserves were not that large. "At a low plant density of 17 stems per square metre, which is unrealistic in the commercial setting, the storage capacity turned out to be just five to ten percent," says Van den Boogaart. "At higher densities, that percentage was even lower. Also, after another measurement on day 53 it turned out that the carbohydrates were being used again later on. This is an important piece of information." "This, plus the fact that the plant develops



**Stefan van den Boogaart (left):** "A lower plant density seemed not to impact on the use of light for photosynthesis."

so many more side shoots when more assimilates are available, has led us to the conclusion that the spray chrysanthemum hardly ever has enough assimilates," his colleague says. "There is no ceiling. Growth of side shoots and flowers never stops. That means that if you cut down on lighting, you will almost always lose out on quality."

## Spray chrysanthemum insatiable

Lighting less in the last part of the cycle is also not a good idea, Hogewoning suggests. "At that stage, the plant is still making a lot of use of the sugars it generates. So it's worth keeping the lights on while the flowers are not yet shading light off the leaves."

That may not be the positive outcome they were hoping for, given the underlying concept of 'Greenhouse as a Source of Energy'. "But that's just how it is. The spray chrysanthemum is insatiable. With disbud chrysanthemums, which have all the side shoots removed, it may be a very different story, of course."

Ultimately the aim of the wide-ranging greenhouse trials was to collect data for a model study with the Virtual Greenhouse. "That also revealed that there is not much you can do in terms of cutting down on lighting," Hogewoning says. "If you have a fixed daylight threshold (390 W/m<sup>2</sup>) there is a brief moment when the supply of assimilates is higher than the demand, but most growers tend to work with a variable daylight threshold. And the surplus is soon used up in that case."

## Huge database

The fact that the result has not delivered the hoped-for answer in terms of energy savings

does not mean that the trials were a waste of time and that there is little that growers can do. "If you want to switch from HPS to LED, for example, you can now have precise calculations done to work out what that will do to the heat balance in the greenhouse," the researcher says. "Also, the calculations from the Virtual Greenhouse can help growers steer their crops much more precisely. If a customer asks for a flower weighing 90 grams, it's a waste to grow ones weighing 95 grams. Instead, you could grow more stems per square metre."

This is very interesting for growers who want to invest or make strategic choices, the two conclude. "We now have such a huge database for the chrysanthemum that it would be a shame not to make use of it."

## Summary

Researchers have investigated the perfect climate conditions for growth, kilograms, transpiration and colour of spray chrysanthemums in all seasons with different plant densities and crop durations. The hope was that energy could be saved by lighting less, but after extensive trials and a model study they have concluded that it is almost impossible to cut down on lighting without sacrificing quality. A large database has been built up which can help growers make strategic choices and decisions on future investments.

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Pieter Slaman, Head Grower/Manager: "We grow a year-round safe, sustainably produced and above all fresh lettuces."

The operation is running for 20 hours a day, seven days a week

## 'This greenhouse has everything a grower could dream of'

**Little Leaf Farms is a semi-closed high-tech greenhouse facility in Devens, Massachusetts, USA. Horticultural entrepreneur Paul Sellew was keen to offer consumers in New England fresh, locally grown lettuces all year round. The result is a hydroponic greenhouse operation based on state-of-the-art technology that is revolutionizing the lettuce market in New England and beyond.**

Founded in 2016, the company produces lettuces hydroponically on 2 ha for sale throughout New England. The US lettuce

industry has traditionally been dominated by growers on the West Coast. "But that often meant that consumers were being sold lettuce that had been harvested in California almost a week previously," comments Pieter Slaman, Head Grower/Manager. "Freshness is everything. Our lettuces are cut and in stores on the same day."

The company supplies its lettuces directly to 2,500 supermarkets throughout New England, including big names such as Market Basket, Big Y, Hannaford and Ahold Stop & Shop, as well as to the food service sector through several distributors.

### Winning formula

It was a conscious decision to focus on just three lettuce varieties. "Having worked for many years at a large grower in the Netherlands before moving here for Little Leaf Farms, I know just how difficult it is to produce high-quality vegetables. So, when Paul Sellew took me on to help him set up the operation, I advised him to keep things as simple as possible," explains Slaman.

"We started off small, on one ha, with just one green leaf, one red leaf and one rucola variety. On a trip to Finland, our EVP Sales & Marketing Tim Cunniff and I spotted a variety

Continued  
on page 16 >



*Phase 2 (middle) was added after just one year, doubling the size of the greenhouse. Phase 3 (bottom) was completed in April 2020.*

that was a cross between an iceberg lettuce and a romaine. We knew if we could grow that on a baby leaf system it would be ideal for Caesar salad, which is very popular in New England. We might expand our range later, but our customers are so pleased with the quality of our products that they tell us: ‘Don’t change the winning formula. Just give us more.’ The company added another ha to double the size of the greenhouse after just a year. phase 3, completed in April this year, has increased the greenhouse by a further 1.5 ha.

### Surprising climate

“We had our fair share of teething troubles in the first year, but that’s normal for most companies,” recalls Slaman. “One challenge for me was adjusting to a region without a strong greenhouse culture. I soon realized I needed to go back to basics when training new employees, to make sure everyone was clear about what’s expected of them. But we soon got people up to speed.”

The firm now has 57 employees in total. Two shifts of up to a dozen people in the

greenhouse itself keep the operation running for 20 hours a day, seven days a week.

“I was also surprised by how much the New England climate fluctuates; it can change from rain to sun very quickly, even on the same day, and the heat builds up rapidly,” he adds. “We use an active water-chiller cooling system to prevent the crop from getting too hot in the brutal summers.”

### Director of Food Safety

Food safety is really important to consumers and customers alike, especially following various E. coli scares in the USA. But the company is well positioned to eliminate any concerns. “We have a rigorous focus on hygiene, and perform thorough cleaning all day long, every day. We also have a Director of Food Safety who ensures that everyone sticks to the food safety protocols in our greenhouse and packing area,” comments Slaman.

And hydroponics is a naturally clean and safe production method, of course, since there’s no contact with soil. “We’re strongly focused on sustainability, so we use a biological control system instead of pesticides, and our heating system captures and reuses CO<sub>2</sub> in the greenhouse for plant development. All our water comes from a rooftop rainwater collection system which includes a UV filter for disinfection. For the past three months we’ve been injecting liquid oxygen into the water supply tanks too, taking it from 6% to 14% oxygen. That makes it easier for the roots to take up fertilizer, so the plants grow faster and healthier.”

### Hands-free mobile gutter system

The greenhouse has several other high-tech features. “We have a ‘hands-free’ mobile gutter system, which is a double-layer system with a germination layer underneath – so each ha actually amounts to 1.4 ha, and phase 3 has actually added 1.9 ha of production capacity,” says Slaman.

“The seeds get four days of light to help them germinate and are then moved up to the top layer. The whole process takes 24 days, from sowing to harvesting. We have 23 growing systems, and we sow and harvest 100 gutters in each one, fully automatically, every day of



*Growing on rockwool and gutters...*



*a cross between an iceberg and a romaine...*



*automatically transport to the processing area...*



**Tim Cunniff (Co-founder, EVP Sales) and Pieter Slaman (right) spotted the market potential for an iceberg/romaine cross.**

the year. In terms of other technology, we also have triple screens, LEDs... everything a grower could dream of!"

### Hybrid lighting system

On the topic of high-tech lighting, LEDs have been used in the greenhouse right from the start. "PB Tec have really done a great job for us with the water treatment system, the computer system, the electrics, everything. They put us in touch with Oreon for lighting, and we started out using just red/blue LEDs: Grow Light 3.0 LLF spectrum narrow beam and Grow Light 3.0 MB wide beam. We've since switched to a hybrid system of red/blue LEDs plus 1,000W and 600W high-pressure sodium (HPS) for the extra heat, especially at the top of the greenhouse on the long winter days. That has made the lettuces grow a lot faster," he continues.

### Water-cooled LEDs

Oreon's unique water-cooled concept ensures that the LEDs and the electronics are continuously cooled, regardless of the ambient temperature in the greenhouse, which guarantees optimal lamp performance and extends the life of the components.

The supplier works closely with Slaman to help him fine-tune the spectrum: "We're a successful team. For me, it's not just about getting the maximum energy out of a kilowatt of light, but also about looking at what kind of light the plant needs to grow. There's a reason that the sun is made up of more than just red and blue light!" The company has recently added full-spectrum LEDs to its existing hybrid system. "My ultimate aim with lighting is to eliminate the seasons – I want to create the optimum lighting conditions for each period to maintain high product

quality and high volumes all year round," he states.

### Future

Now that phase 3 is complete, the company has reached its expansion limits at the Devens site. But its growth continues, and plans are already in place to build a 10 ha facility in Pennsylvania to serve the Mid-Atlantic states as well as the New York market, where Little Leaf Farms already has a small foothold. "That greenhouse should be ready in spring 2021 – and then consumers throughout the Greater New York area will soon be enjoying our fresh lettuces in their Caesar salads too," concludes Slaman.

## Summary

US-based Little Leaf Farms has become a resounding success in a short space of time, and now sells the most controlled environment agriculture (CEA)-grown lettuce in the country. The fully automated 2 ha greenhouse enables the company to guarantee leading retail and food service customers in New England a year-round supply of safe, sustainably produced and above all fresh lettuces that are a big hit with consumers.



*automatically cutting the leaves...*



*directly sold to 2,500 supermarkets.*

Fertilisation specialist Geerten van der Lugt:

## ‘More insights needed to achieve real precision fertilisation’

**Fertilisation is an ancient discipline, but many growers still find it tricky. There is no cookbook with standard recipes you can use for any occasion. Precision fertilisation calls for a thorough basic knowledge on the part of the grower, but the scientific insights that are needed to implement it properly are also inadequate.**

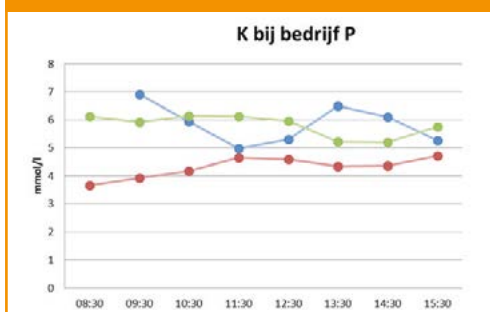
Since the turn of the century, a lot of money has gone into researching lighting, irrigation, plant health and Next Generation Growing. In contrast, fertilisation has come off slightly less well. “What we do these days is still very much based on developments back in the 1970s and 1980s. The principles are still the same. Some things have been improved, of course, but more needs to be done if we are to achieve real precision fertilisation,” says independent plant nutrition consultant Geerten van der Lugt (in comparison to crop growth and water).

### Generation difference

For many growers, fertilisation is a tricky subject. You have to juggle twelve different nutrients, each of which behaves differently, combined with pH, EC, salt and bicarbonate. The ratios between the various elements are important, but growth stage and climate also play a role. Linked to that are water and nutrient dosing. Growers often play it safe.

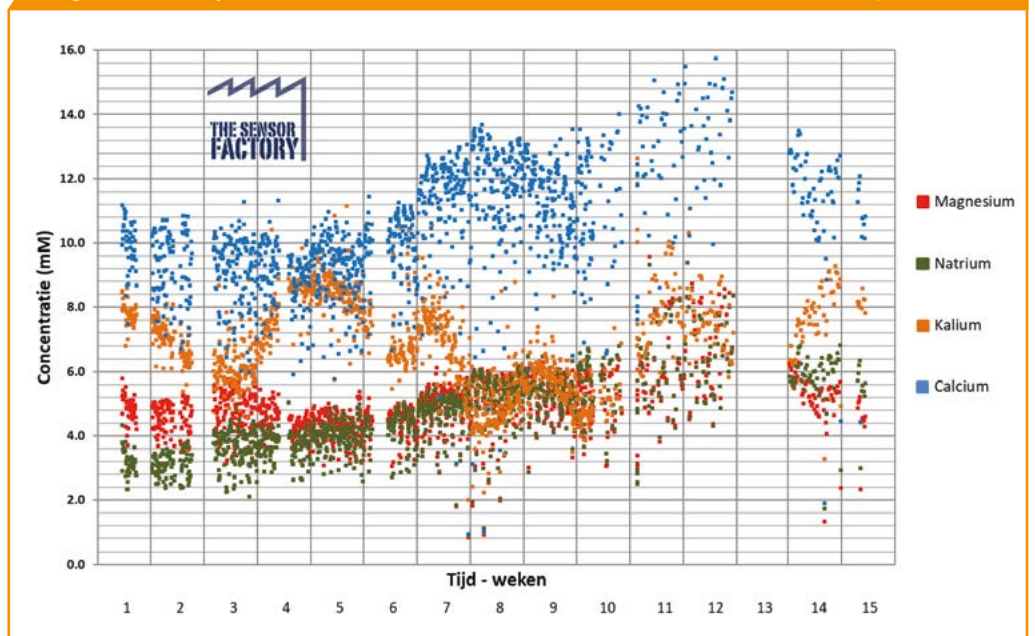
Van der Lugt has noticed that older generation growers find it less complicated

Figure 2. Development of potassium levels in drain water



**Fluctuations in potassium levels during the day in drip, slab and drain water at a cucumber nursery.**

Figure 1. Hourly measurements of four nutrients in drain water tomato crop



**Hourly measurements reveal major variations in the levels of nutrients in the drain water, particularly calcium. Sampling once a fortnight does not show this.**

than younger ones (below the age of 40). “The older generation really does know more about fertilisation; not just from experience but because they were taught it properly at some point,” he observes.

“A lack of basic knowledge can be a hindrance if you want to move towards precision fertilisation. These days, one aspect is being neglected: the plant has to use up valuable energy coping with a suboptimal root environment. It’s hard to quantify, but you can see the push for improvement in all areas of horticulture. Up to now, fertilisation has lagged behind.”

### Large greenhouse sections

Some things have improved over time, of course. Take water quality. “Good input water is the basis for fertilisation, and that has got a whole lot better. The same applies to the fertilisers themselves; they now contain less salt, for example. Recirculation is the norm these days. And more attention is being paid to nutrient uptake using methods such as plant sap analysis and uptake calculations.”

On the other hand, growers are focusing less on managing the crop via the EC. But

that is typically an area where there is room for improvement. “Everyone knows about EC light reduction, when you reduce the EC in sunny weather. And everyone agrees that that is a good idea. But you still come across plenty of growers who find it too complicated, perhaps because they find their irrigation system too slow. It is true that systems have become less flexible as section sizes in greenhouses have increased, whereas what you really want is more flexibility. And how you get that flexibility back is a moot point,” he says.

### Precision fertilisation

Growers who keep their finger on the pulse and carry out regular analyses can’t go wrong. But there is still room for improvement. “We currently follow a pattern of sampling once a week or fortnight. That’s enough to make sure nothing out of the ordinary is happening. If you always take samples at the same place and time, you will always get nice straight lines. But if you measure more often you will see some variation creeping in.”

When more frequent measurements are taken, it not only becomes apparent that the concentrations in the irrigation, slab and

drain water behave differently (figure 1) but also that the concentrations in the drain water fluctuate enormously (figure 2). What information you get therefore depends greatly on when you take the samples. That variation during the day and over the weeks could be providing you with more information, such as uptake pattern, day/night rhythms, weather influences and water and nutrient uptake. This information can be extremely useful for tightening up your fertilisation strategy. At the very least, precision fertilisation should mean an increase in yields of a couple of percent, Van der Lugt believes.

### Ion-specific monitoring

It is a complex subject, but surprisingly, this hasn't changed. Ion-specific monitoring has been looked at several times in recent years. The technique for this is robust enough nowadays, but there is a lack of scientific insights around what to do with the results. So progress needs to be made in this area while continuing to carry out practical monitoring. Then there is the matter of the process technology. So growers really need to be able to fertilise more flexibly, otherwise they won't benefit from the insights. The consultant: "Recently there has been a trend towards large greenhouse sections controlled based on the fertilisation unit. That inhibits development. But first things first: we really need better insights. Until we can convince growers that they could be doing this better, nothing will change from a technical point of view either."

Even growers who already have the technical facilities in house, such as an automatic dosing system for liquid fertilisers, are not using them. You can set up dozens of fertiliser formulations in systems such as these. But growers generally only use two: an initial plan and a flowering and fruiting plan.



**Geerten van der Lugt:** "Substrate growers are increasingly looking to soil growers for information on soil biology."



**The technical facilities for dosing fertilisers separately do exist, but the lack of insights means that growers tend to stick to two fertilisation plans.**

### New balance

In the 1990s, growers growing in soil started looking enviously at what substrate growers were doing and copied many of their ideas, such as high fertilisation levels via drippers. The soil was treated like substrate, which led to structural problems such as compaction, capping and poor water management.

Those days are behind us now. The realisation that soil structure is important is back with a vengeance. A lot of knowledge from outdoor cropping is finding its way into greenhouse soils and growers are once again paying attention to soil biology.

Van der Lugt: "It's something that needs more work, and now we're actually seeing substrate growers looking at what soil growers are doing in this area. But there are a lot of misconceptions surrounding soil biology. In outdoor cropping, fertilisers and organic materials first have to be mineralised before they are taken up. That is mainly a biological process, in which soil biology plays a very important role. Indoor growers are used to using a lot of manure in soil cultivation, which has led to them neglecting the soil biology and therefore making mistakes. Now what we need to do is find a new balance."

### Soil biology in substrate

Van der Lugt sees similar arguments for substrate but emphasises that this is very different: "On substrate you don't need the

soil biology to make the fertilisers available to the plant. In the field and in nature, mycorrhizae play a role in the uptake of elements. But plants grown on rockwool produce no fine roots at all, so they can't be colonised by mycorrhizae. They have a useful role to play in natural soils but they don't help you at all in substrate."

However, there is another good reason for taking a serious look at soil biology in substrate. "Soil bacteria and other organisms can be beneficial in terms of resilience. But more development needs to take place before we can make targeted use of that. The line between ecology and practical research needs to be stronger if we are to develop a vision in this area."

### Summary

In the research, fertilisation often plays second fiddle to topics like water, light and plant health. To enable growers to achieve precision fertilisation, better scientific insights are needed along with constant monitoring and flexible process technology, says fertilisation consultant Geerten van der Lugt. More knowledge of soil biology is also needed if we are to develop a vision in this area.



*Martin de Hoog: "Root pressure is now more constant, which means less stress in the growing environment. And with the plant better under control, we also have less Mycosphaerella damage."*

Irrigation based on dry-down and drain

## Cucumber grower De Hoog: 'Transpiration as an irrigation indicator'

**Martin de Hoog from Pijnacker in the Netherlands is right on the ball when it comes to growing cucumbers and is always looking for ways to improve production. This includes having a proper irrigation strategy, something he feels is often overlooked. "Everyone talks about energy, but water is also a factor in Next Generation Growing. It's worth looking at carefully."**

Cucumber grower De Hoog was already working with the Priva Root Optimizer. Last January he upgraded to the Moisture Balance Module (MBM), which takes some of the guesswork out of the irrigation scheduling.

Martin and Georgette de Hoog recently installed a second energy screen in their 14,500 m<sup>2</sup> nursery. The changing greenhouse climate prompted them to take a fresh look at their irrigation strategy. De Hoog: "The entire moisture balance in your greenhouse changes, so it makes sense to adjust your watering

cycles accordingly. And for us, it also goes without saying that we mainly look at plant transpiration. Our account manager Kevin de Kok drew our attention to the new module, which was a logical follow-up to the system we already had. It's only been up and running for a few months, but I firmly believe this is the right way forward."

### Less water, improved quality

Besides weighing scales and a drain meter, the module includes software that enables the grower's climate computer to communicate with the irrigation system. The combination of these components ensures dynamic irrigation at the pre-set daily drain percentage. Based on the readings, the module constantly calculates plant transpiration. If there is too much or too little moisture, this is adjusted incrementally during each cycle, mirroring the way the transpiration rate gradually increases or decreases. If you focus on light intensity, these differences are often

more of a shock to the plant.

According to De Hoog, this more precise way of working is reflected in the condition of the plants. "Root pressure is more constant, which means less stress in the growing environment. And fortunately less Mycosphaerella damage. Quite simply, you have better control of your plants. I don't know whether it improves yields, but I can assure you I've used less water per cucumber this season and have actually seen an improvement in quality."

### Less stress

The grower is learning to operate the new system effectively, with support from Kevin De Kok: "We check the settings together on a regular basis. Martin knows more about what the plants need during the various growing stages and seasons, while I can translate his comments into technology. That way we learn from each other."

The module allows growers to adjust five settings: the start and end time, the cycle

length, the daily drain, the maximum drain per cycle and the minimum transpiration before the system kicks in. Both start time and end time are dynamic. If the required cycle drain level has not yet been achieved, the module automatically adjusts dry-down. De Hoog: "If I've set a drain level of 30 percent and the slab dries out too much during the night, the system simply initiates an extra cycle, or even two or three. It's self-regulating. So the plants are always in perfect condition in the morning. Once the system has completed the first cycles and measurements, it automatically calculates the irrigation strategy required for the rest of the day to achieve the daily drain level I've set. As I said, that means less stress in the crop."

### Cruise control

De Hoog shows us the entry page on his computer: simple and effective, and requiring no special training to complete. He is happy with the new software and the results obtained in his greenhouse. "I'm convinced it's better to base your irrigation on plant transpiration and overnight slab dry-out than on the radiation sum. And this new system hones our old strategy. It looks ahead and



**Martin de Hoog and Kevin de Kok (right):** "The irrigation volume is determined based on dry-down and drain."

automatically anticipates changes in the root environment. Personally, I think it's a big advantage to have watering based on weight carrying on as usual when the lights are out and the plants are still transpiring. Like a kind of cruise control."

Other growers have been keeping a close eye on proceedings. "Most of them thought I was crazy and made comments like: 'Surely you don't configure your watering regime

based on readings from only eight plants?' But I think that tends to give you a better average than having just one radiation meter on your greenhouse roof."

### Developing insight

Irrigating using the MGM is just like cooking, jokes De Hoog. "Once you've got the basics sorted, you just need to pep it up with some seasoning and a sprinkling of spices. It's actually very simple once you grasp the principle. And that's the most important thing as far as I'm concerned. It's all very well for technology to play such a key part in our horticultural business, but I need to really understand the system.

"I want to be able to interpret the measurements myself and agree with the actions it takes. It's no good me doubting the equipment. This spring we turned the system off for a while and went back to the old method, just using weighing scales and a drain meter. Then we ran the two systems together at the same time for a bit, which enabled me to directly compare both sets of results. Of course, in a situation like that, the grower's green fingers still win out over the equipment. It was only when the readout results began to match up that my confidence was restored."

Blackberry grower Wouter van den Bosch:

### 'You have to get used to a system that thinks for itself'

**Bosch Fruit in the Dutch town of Berkel & Rodenrijs (1.3 ha) has been using the new irrigation system since March. And it takes some getting used to, admits Wouter van den Bosch. "As a grower, you normally try to interpret all the different factors yourself and translate that information into the right irrigation strategy. Now the module takes care of all that, instantly and dynamically."**

Light, moisture, cropping stage, time of day – every time something changed you'd have to rush back to the climate computer to alter the setting. Now the Moisture Balance Module takes care. "At first it felt really strange; you have to trust it. Now I have a better understanding of how the system thinks," Bosch says.

### More stable irrigation

Instead of reacting ad hoc to changing circumstances (indirect irrigation), the software module adopts a strategy consisting of several phases, explains the grower. "Irrigation is not initiated until the plant is active. The drain level is set and the module then works towards it. Once the desired degree of saturation has been reached, it's important to maintain the moisture level. During the final phase, the slab is allowed to dry out to the required



level. The cycle then starts over again with phase 1. Now that I have a better grasp of the different steps, I also know which settings to choose, as the system allows the grower to enter all the target values for each phase in advance.

"It's all very clear, although I did have to phone the process automation people a couple of times before I figured it all out. But now it practically runs itself, even when you're not around. Having said that, you do have to keep an eye on it from time to time. The other day there was a snail in the drain meter and the system couldn't work out what was happening. Luckily, there are all kinds of alarms built in as well. That's all part of the learning curve too. We're delighted we made the investment. It's still early days of course, but already I can see that irrigation is now more stable, with fewer errors."

### Summary

Cucumber grower Martin de Hoog has installed a new irrigation system that focuses less on external factors and more directly on the moisture balance in the crop. It determines the irrigation volume based on dry-down and drain, values that growers can pre-configure. Over a 24-hour period, it works out the strategy required to actually achieve those values. The result is more stable irrigation and a more constant root environment.

Next Generation Growing and screening in summer

## Screening more has positive impact on crop health

**Screening at the beginning and end of the night in the summer may not sound like a logical thing to do if the temperature has been high during the day. But crops react very well to this screening strategy. Problems such as glassiness, condensation and guttation occur less frequently, so the crops stay healthy. But it is important to find the right method for each crop.**

More and more pot plant growers are achieving positive results by closing the screens earlier at the end of the day in the summer. This cools down the crop gradually before nightfall. Dutch consultants Marcel Lieffering and Wim van der Ende are seeing more and more growers adopting the principles of Next Generation Growing (NGG), and part of that is preventing outgoing radiation.

### More complicated

Marco Koolhaas, who grows bromelias with his brothers Wim and Hans in the Dutch town of Moerkapelle, has taken the basic NGG course several times. He applies the principles at their family business, LKP Plants. "I'm starting to understand NGG a bit

better now," he says. "Applying it is more complicated than you think. You try something out but then it can be a big disappointment if things don't work out the way you expected."

### Sensitive to stress

Many bromelia cultivars are sensitive to light. To protect the plants, therefore, the greenhouses at LKP Plants are fitted with three screens. Two are summer screens with differing levels of light transmission and one is a slightly diffuse energy screen. A combination of these screens is used to keep the RH (relative humidity) in the greenhouse high and stable. If the plants become stressed, it is difficult to get them back on track, Koolhaas finds. The screens close up to a maximum of 85%. In intensive light they stay closed for longer, and when the light is less intensive they are left open for longer.

The daytime temperature rises high during the day. Like other growers, Koolhaas would always open the screens in the evening to bring down the night-time temperature slightly. Not doing so can mean excessive overnight temperatures – up to as much as 28°C. Outgoing radiation is then an effective

way of lowering the temperature. At least, that was the thinking behind it. But it is the temperature of the plant that this method brings down substantially, not the greenhouse temperature.

### Glassiness

This method has other consequences. In the morning, crops can often be covered in condensation, root pressure can cause guttation, or the leaves can become glassy (damaged cell walls), with all the attendant problems these cause. It is actually very logical. In warm weather the plants take up a lot of water, which increases pressure on the cells. Outgoing radiation causes the leaf temperature to drop compared with the ambient temperature, which inhibits transpiration via the stomata.

Lieffering: "The problem with glassiness is that you don't notice it happening. Our regimes are geared towards the greenhouse temperature, not the plant temperature."

This is more of a problem for nurseries with concrete floors than for those growing on mobile benches. Because the concrete floor absorbs heat, the pot temperature takes longer to respond and the roots stay active for longer. Koolhaas grows on mobile benches with a grid surface, so this wasn't too much of a problem for him.

### Uniform transitions

"By screening for an hour longer in the evenings and mornings, you can make the transitions uniform," Lieffering says. "We started using this method because of NGG, although mainly to save energy." This is less of a concern in the summer, but the transitions between day and night at that time of year can be tricky. Therefore, an additional advantage of this screening strategy is that the transitions are less abrupt. But this theory has turned out to be difficult to apply, not least because of the big variation in crops, their sensitivity and the range of different equipment in the greenhouses.

The consultant compared two sections in one grower's greenhouse. The first section was screened following the usual regime. The



*In the summer, screens are increasingly being closed at the end of the afternoon until one hour after sunrise.*



**Marco Koolhaas (left) and Marcel Lieffering:** “The problem with glassiness is that you don’t notice it happening. Our regimes are geared towards the greenhouse temperature, not the plant temperature.”

screening in the second one was varied, with the screens being closed earlier in the evening and opened later in the morning. There was condensation on the crop in the section following the traditional method, but much less in the other one.

### Understanding processes

A number of growers adapted their screening regime last summer. Koolhaas was one of them. “We got through the warm period well and the quality of the bromelias was great,” he says. “Understanding the processes helps you optimise the crop.”

The bromelia grower has had PAR meters in



**Some hydrangea growers give a heat boost with the grow pipe three times a night to control Botrytis.**

the greenhouse for many years. Since taking the NGG course he has also had a pyrgeometer connected to his climate computer, which enables him to see what is actually happening. “A pyrgeometer is a worthwhile investment. You can use it to target your crop management, and that will save energy.”

They have started venting less above the screens, he reports. When there is a lot of outgoing radiation, minimum vent is reduced to 0%. That allows the glass to cool down enough for the warm air to condense while still enabling moisture to be removed.

“You have to keep asking yourself whether and how you need to vent,” Lieffering adds. “It depends on the situation. The more closed the greenhouse is, the harder it is to remove moisture. Sometimes you need a minimum vent opening. Some people measure the temperature above and below the screen and link the data from the pyrgeometer to that. Others simply close the screen based on gut feeling.”

### Cymbidium and hydrangea

New screening strategies are appearing, both for heat-loving crops but also for cooler ones such as cyclamen and hydrangea. NGG is not straightforward for growers to apply. Wim van der Ende, who mainly advises growers growing cut cymbidiums, roses and hydrangeas, has also noticed this.

“We have been working with this principle in cymbidium for a couple of years now, purely because of the energy you can save,” he says.

This method is not entirely new. It was also used back in the 1980s, but at the time it tended to produce weak plants. These days growers reduce the greenhouse temperature at the same time, followed by the pot temperature. The screens generally close 80%. At that point the negative effect of outgoing radiation stops and it is still possible to remove some moisture.

Some growers give a heat boost with the grow pipe three times a night. They do this to control Botrytis, which germinates after four hours. Giving the crop some dry heat therefore prevents mould formation.

Hydrangea growers also use this technique. This crop is susceptible to both Botrytis and glassiness. Van der Ende: “But I do want to emphasise that glassiness and guttation are not just a climate issue. Both have to do with the nutrient status, as poor nutrition can cause weakness in the root system.”

## Summary

Growers of both heat-loving and cooler crops have started to screen more and for longer as they apply NGG principles. Increasingly, they are happy to screen in the mornings and evenings in the summer, even if daytime temperatures are very high. This reduces condensation, guttation and glassiness while at the same time improving quality.



## Leaf miner

The leaf miner is mainly found in tomato and aubergine, sometimes in sweet pepper and occasionally in cucumber. In summer, *Diglyphus* parasitic wasps are generally an effective control. But you will need to monitor the situation closely in the autumn. If the population of leaf miners unexpectedly reappears, it is important to take action.

Look out for fresh feeding spots and young leaf miner larvae in young leaves or lateral shoots. These larvae could still have

time to pupate. The pupae that occur in the autumn will stay dormant for much longer on average than those that occur in the summer.

Any pupae that remain behind in the greenhouse at crop changeover are a potential threat to the new crop as they can emerge over a period of several months. An infestation in the spring in the young crop can therefore be insidious and difficult to control. So stay alert!

Website completely revamped

# In Greenhouses now also available with digital subscription

**Although In Greenhouses is primarily a paper magazine, we are gradually seeing a growing demand for digital subscriptions. More and more paying subscribers prefer a paid digital subscription. This is now available on our completely revamped website.**

“For the most part, growers still prefer to receive industry information in print, so we are certainly continuing with that,” publisher Wouter van Esch explains. “But more and more paying subscribers would rather have a paid subscription that is available online. An online subscription is particularly useful in countries where postal deliveries are not always reliable.” Providing the magazine to high-end greenhouse growers all over the world free of charge still remains the basis of In Greenhouses, however.

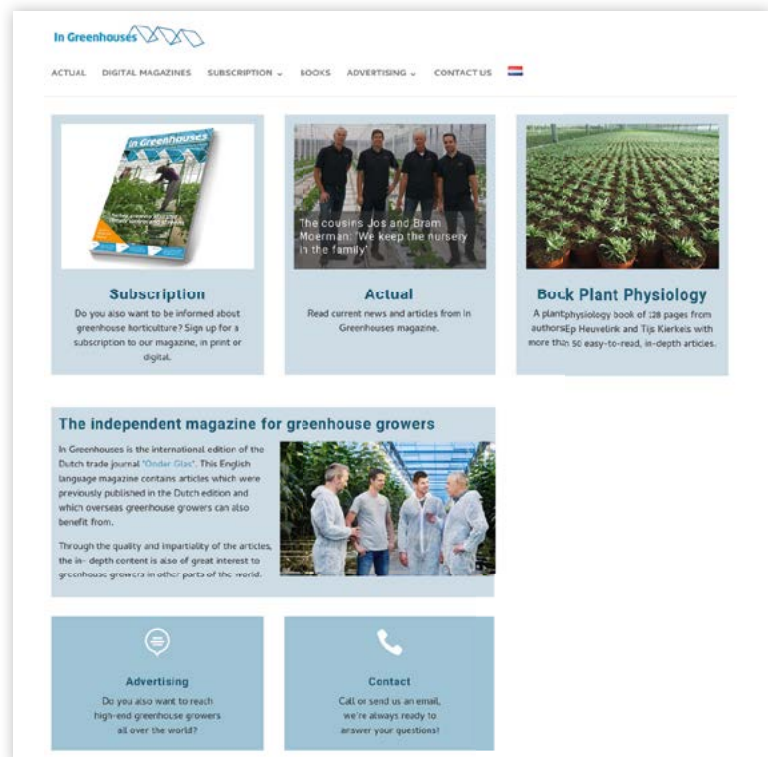
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Use of peat frowned upon in some countries

## Biochar can replace peat by up to 50% in strawberry substrate



*Nina Oud: "This charcoal product can quite easily replace some of the peat – the more, the merrier, up to 50 percent substitution."*

**The second study into the possibilities of biochar in horticulture by researcher Chris Blok will soon come to an end. In it, Wageningen University & Research (WUR) has been investigating whether it can be used as a partial peat substitute in strawberry potting composts.**

The research also looked into the question of whether the material can give beneficial soil organisms a better chance of establishing. The researcher believes it has fruitful applications but thinks it will be slow to become commercially available.

### Horticultural requirements

Biochar. Blok can't stop talking about it. In theory it offers a solution to several problems, and in practice too it has a number of very interesting applications. Commenting on the relative stagnation of its use in practice, the researcher explains: "The biggest stumbling block is the production process. At the moment, there simply aren't any factories that are properly equipped to produce products that can be used in horticulture. Bear in mind that if it's produced wrongly, it's toxic to plants. Also, a dusty, unstructured product is a hard sell for substrate suppliers."

### Type of charcoal

In America and Australia, on the other hand, the horticultural and forestry sector has moved on. There, farmers incorporate the product into the soil to improve vitality and structure. "Biochar increases the organic matter content," Blok explains. "It allows them to bring poorer soils back into production. We still have a long way to go in the Netherlands before we reach that stage, although the search is on for applications for this typical 'transition product'. You see, it's a by-product from the production of biofuels and bioplastics from organic residues – a type

of charcoal. Wouldn't it be great to be able to use it in horticulture? It would be a win-win situation. That's what this research is all about." The research was co-instigated by the Ministry of Economic Affairs and carried out in collaboration with the Dutch Energy Centre (ECN).

### Alkaline counterpart

While any toxic side-effects in open field production are buffered away, much more precision work is called for in horticulture. "If the gases it releases are not removed separately during the production process, we can't use the product. For the time being, 'clean' product is very hard to come by, and suppliers often have to produce it to order, so it is too expensive for large-scale use. But that could change in the future, and so our research continues – in this case into its potential as a peat substitute in potting compost. Not least because the use of peat is severely frowned on by consumers in some countries."

The combination is obvious: the acidic peat is neutralised by the more alkaline biochar. And provided it is produced properly, the same density of both raw materials creates a homogeneous, workable mixture. According to Blok, potting compost consisting of 100 percent "charcoal" is not an option due to its high pH.

### Infused with organisms

For the research Blok and his colleagues Andrea Diaz and Nina Oud produced a series of mixtures with 10, 20 and 30 percent biochar and the rest peat. The mixtures either contain some beneficial soil organisms (*Trichoderma*) or none at all. Strawberries, half of which were inoculated with *Phytophthora*, were planted in the mixtures.

The researcher: "Beneficial fungi or bacteria can boost the resilience of plants. The problem is that nine times out of ten, they die in the soil. They simply don't fit into the balance of the substrate. That's why we came up with the idea of pre-loading chunks of "charcoal" with these live biostimulants. So essentially you're giving them their own castle from



The material resembles charcoal.



Chris Blok: "It would be great if we could use this by-product of biofuels and bioplastics in horticulture."

which to conquer the soil."

However, this study does not conclusively demonstrate whether the soil organisms actually have an effect. The conventional measurement method was not effective. "This is because the organisms establish in large and small foci that criss-cross the mixture. The results of the samples we took didn't produce a representative picture. For example, a sample may indicate 0 even though there are organisms present just a few centimetres away. It was a shame, but definitely a learning curve for us. We will definitely be looking for a suitable measurement method to investigate the carrier properties of biochar."

### Impact on fruit weight

The second setback was the *Phytophthora*. The infected plants showed hardly any visual signs of disease, so the disease-suppressing effect of the infused charcoal product remains unclear for the time being. When they measured the plant mass after 13 weeks, the researchers found no differences between the plants that were infected and those that weren't. Interestingly, lab tests at Groen Agro Control revealed that the submitted plant material from the biochar-rich mixtures scored lower for *Phytophthora*. Blok: "This could mean that there is a correlation between this growing medium and the presence of diseases. Very interesting."

Nina Oud also investigated the fruit weight obtained from the potting soil mixtures tested. This produced a rising trend; more biochar gives a higher fruit weight. She explains this as follows: "Biochar is drier than peat. Mixtures that contain a higher percentage are therefore more generative."

These are all positive results that prove that this is an entirely suitable root medium for strawberries. In the search for raw materials for substrates, this charcoal product can therefore quite easily replace some of the peat – the more, the merrier, in fact (up to 50 percent substitution).

### Hollow structure

At the same time, the results are prompting Blok to undertake further research. "Biochar has a nice hollow structure. Suppose we were to enrich it with compost, for example? Who knows – perhaps added fungi and bacteria would then adhere and thrive better in the potting compost mixtures. After all, some manufacturers do claim that this is possible and that they have already developed these kinds of mixtures. Naturally, we are happy to provide the scientific evidence."

## Summary

Biochar, a type of charcoal, can be used as a partial peat substitute in potting composts. The alkaline and acidic raw materials complement each other, producing a healthy growth medium for the strawberry research crop. The fruit weight and percentage of "charcoal" seem to correlate positively. Further research will be done to establish whether the material can be used to give beneficial soil organisms a better chance of establishing, thus contributing to a more resilient plant environment.

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*Hans van der Lugt: "We will be the first to use Next Generation Growing in Lisianthus. There is already a lot of basic knowledge available, but beyond that we will be finding most of it out for ourselves."*

## Equipment based on the principles of Next Generation Growing

# Building a new greenhouse as a seamless process

**Brothers Peter, Hans, Marcel and Richard van der Lugt are putting their new site into use one step at a time. These Lisianthus growers are hoping that this 6 hectare complex will enable them to do some catching up. Hans: "The main thing we are expecting is an improvement in quality. We got stuck in a rut in our old greenhouse."**

The growers have been working with the consultancy firm AAB right from the start of the project. More than a year before the first

pile was driven into the ground, consultant Richard Groenewegen sat down with the growers to turn their wants and needs into actual possibilities. Groenewegen: "The task was not so much to get the most square metres on the drawing board but to maximise efficiency. The layout was mainly determined by aspects such as the position of the sun, the desired bay length, the optimum working width and access routes. So we had to work out how far we could push the boundaries and how we could integrate everything into one site. You can only build once, so you have

to make sure it doesn't become obsolete after three years."

The result is a traditional greenhouse with a post height of 6 metres, 4.8 metre bays and 9.6 metre lattice girders. The length-to-width ratio is ideal, at 240 by 240 metres. The complex also includes a multifunctional service building and a smart office from which sales are organised.

### Opting for NGG

The brothers have based the equipment inside the greenhouse on the principles of

Vervolg op  
pagina 30 >



**The central aisle is one of the showpieces of the project. It is wider than usual as it is designed to accommodate the ideal working width of the four harvesters.**

Next Generation Growing (NGG). They hope to improve the quality of their Lisianthus with greater air flow and better humidity control. Lower energy consumption and therefore higher efficiency are also on their wish list. To achieve that, they have installed a total of 26 air handling units alternately in the bays, 13 on each side of the aisle.

The system was installed by Technokas, who provided all the calculations the growers asked for in their contract documentation. This was quite a challenge, as the ideal growing conditions for Lisianthus are different from those for, say, chrysanthemum, a segment in which NGG has been in use for some time. The systems couldn't simply be copied across.

Among other things, Hans van der Lugt points out the larger capacity of the air handling units. He is looking forward to seeing the results of the new growing systems. "There is already a lot of basic knowledge, but beyond that we'll be finding most of it out for ourselves."

### Special aisle design

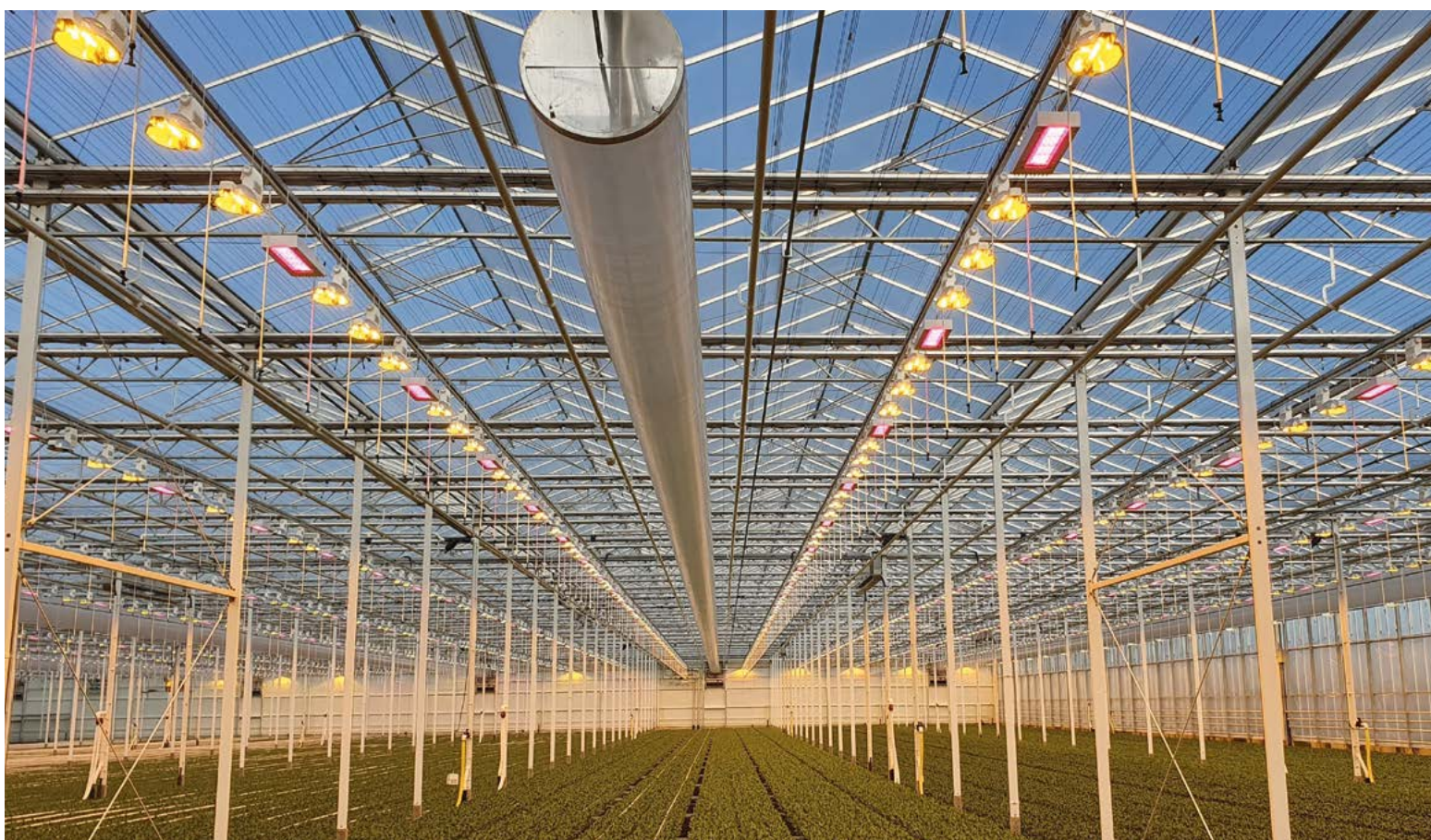
The brothers are fully committed to the philosophy behind NGG. The use of LED lighting will help them achieve their quality and efficiency goals, they say. LED is more energy-efficient than HPS and emits less heat. Here, too, they are looking to push to the limit of what is viable and possible.

"This is such a great project on such a lovely site that everyone we approached got very excited about it," Van der Lugt says. "This produced several very detailed ideas such as the NGG climate control systems I mentioned before. Kubo also came up with a strong concept: an aisle design tailored specifically to the current method of growing Lisianthus. They included a weighted 10-metre-long gutter beam which enabled one row of columns to be eliminated, calculated on the basis of wider aisles for the sticking and harvesting machines and spray robots we use. Very practical, therefore."

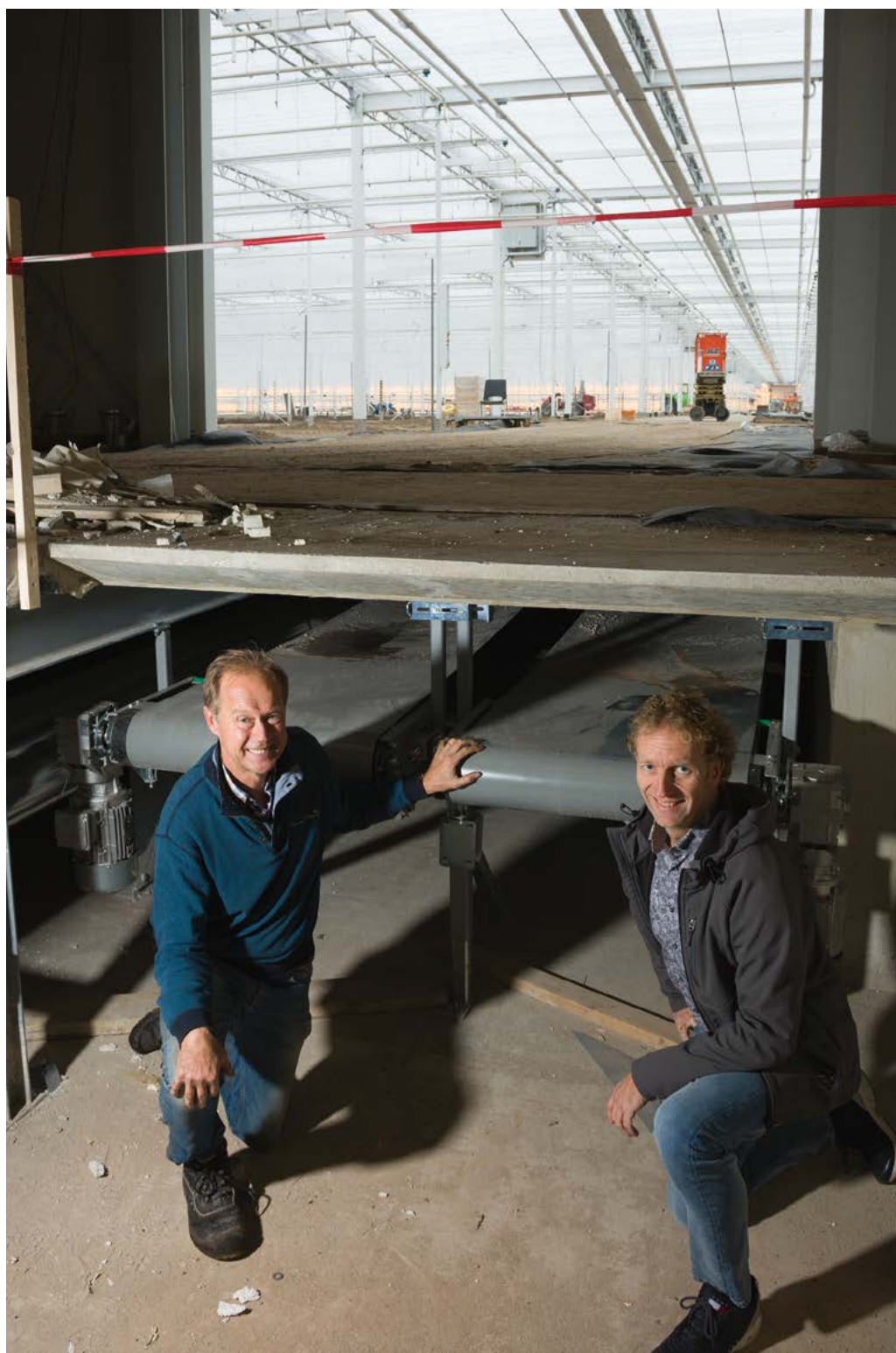
### Three screens within 30 cm

When the screen suppliers installed the three screen systems in the greenhouse, they created a real masterpiece. "The growers wanted to keep the bottom part of the lattice girder free for fitting lights and hoistable heating systems. So we installed three screens within 30 cm – an enormous challenge from a design point of view," says Jeroen de Jonge of Peter Dekker Installaties (PDI). This customisation came about following in-depth consultation with the greenhouse builder and the client.

PDI installed two screens next to each other at the top of the lattice girder: a blackout screen and a summer screen. A transparent energy-saving screen was also installed halfway up the girder. Van der Lugt: "Two of the three screens can be closed simultaneously. The grower will only need to use one of the top two, depending on the season."



**NGG allows for better air flow with lower energy usage. To achieve this, a total of 26 air handling units were fitted on alternate sides in each bay.**



Richard Groenewegen (right): "The 277-metre-long flower tunnel will house four conveyor belts."

### Flower tunnel with four belts

There are other highlights in the complex besides these. The quadruple underground concrete tunnel in which the conveyor belts run is certainly one. That may have been standard equipment for the grower, but it was a tough challenge for the manufacturer. The 277-metre-long flower tunnel was built by Verkade Beton. Prefabricated concrete parts are usually used for these tunnels, but because Van der Lugt wanted theirs to be watertight, it was eventually cast in situ.

The scope of this part of the works called for some out-of-the-box thinking. The tunnel is 5 metres wide and 1.4 metres deep on the inside. Because the concrete path above it would otherwise have exerted too much of a load, the manufacturer built a supporting

structure consisting of steel columns in the centre of the channel which were combined with the metal brackets over which the four conveyor belts run. These non-standard dimensions were specifically requested by the Lisianthus growers. Van der Lugt: "You have to get into the tunnels sometimes to maintain and repair the systems. We don't want to have to crawl through them, we just need enough room to work in them."

### Lots of red tape

The complexity of a project of this kind is enormous. "Real fun," says Groenewegen. "You have to obtain all the necessary permits and win over the authorities. Negotiate with both the buyers' and the sellers' agents. Organise the reconstruction and drawing work and, of

course, design the front with a large service building, the rear exit and the architectural theme of the new office. The best way to go about this is to closely coordinate all the plans with the client and subcontractors: the glass, the energy, the screens, the heating, the steam boiler and the service areas."

### On schedule

Things started to get truly exciting at the beginning of November. The first sections in the greenhouse were steamed and made ready for growing. They were planted up in week 44. The closer it got to the planting date, the more the growers were able to take control. Groenewegen points towards the back. "Look, that's the back entrance over there where all the cuttings material and the soil cultivating machines come in. Then they work their way to the front."

The harvested stems leave the greenhouse via the conveyor belt at the front and are taken to the grading and processing area in the service building. Here the product is prepared for sale and leaves the nursery for the customer via the loading docks.

### Experience and flexibility

One of the main reasons the project ran so smoothly was communication, Groenewegen says. "Even though I was dealing with four different contractors, everyone was on the same wavelength. They were all fully on board and I always got clear answers to my questions. When that happens, you can act fast." The same level of commitment was shown by the suppliers and manufacturers too, Van der Lugt adds. "We were looking for a team of people we could trust. Reliable companies with a good reputation who have the flexibility to pull off a big project like this one. You just don't want to have to worry about that while the building work is ongoing."

## summary

The Van der Lugt brothers' new Lisianthus nursery consists of greenhouses, a multifunctional service building and an office. A special feature are the systems that will enable the growers to work to the principles of NGG. The grower's main aim in using these techniques is to improve the quality of the end product. In conjunction with a consultancy firm and various suppliers, they continuously pushed the boundaries of what is possible, as the growers are looking to maximise efficiency.

In search of better synergies between plant and soil

## 'Adapting microbiome boosts resilience to pests and diseases'

**Improving plant resilience is the ultimate goal of current plant research. It is an effective way to control pests and diseases and eliminates the need for chemical plant protection products. The answer lies largely in microbiology, with the plant microbiome playing a major role, the scientists say.**

Armed with a whole host of new ideas for increasing plant resilience, improving the soil and getting plants and soil working more in harmony with each other, Wageningen UR Plant Research scientist Leo van Overbeek visits various grower's groups. "We are in the midst of a revolution in terms of technological and conceptual developments,"

he says. "Something new is added every year, and things are developing at breakneck speed. We want to support growers in their quest for more resilient plants."

To achieve this, he is specifically looking at the interaction between fundamental science and commercial practice. "There is a great deal of research being done into plant resilience at the moment, but it's too descriptive, too academic. I want to get the research translated into practice so that we can benefit from what's happening on the ground and growers can find out about us. Also, as a researcher, you get a much better and more immediate dialogue going when you're standing alongside a grower in the greenhouse than when you're working in the lab."

### Plant microbiome

Van Overbeek wants to make plants more resilient to pests and diseases by adapting the plant microbiome. Microbiome research is a new field. "In the past, we would come up against the problem that 95 percent of fungi and bacteria living in the soil couldn't be cultivated so they weren't accessible for research. That also meant that the plant protection products and biostimulants that were developed were only based on the five percent that could be cultivated."

Technology has changed all that over the past five years. "With innovative technologies, we can not only identify the DNA but the RNA too. So we can now see which genes are expressed and which aren't. Besides identifying species, we can now also get to the bottom of what they do. For example, by analysing a plant's leaves we can answer questions like: Which substances does the plant produce when it is happy and which does it produce when it isn't? What is the effect on plants when you add organic residues such as compost? How does a plant react to drought, and what substances does the plant then use to make itself more resilient? We can measure all this with these new technologies."

### Focusing on bacteria

In addition, there is a sea change in thinking going on. "We used to mainly think about things from our own perspective or that of the plant," he continues. "But that's the wrong way to go about it. We need to look at the importance of the bacteria. What it does and why. Thinking conceptually – that's another way to tackle a problem."

Conceptual thinking combined with new technologies makes a world of difference, he says. "We can investigate whether a plant to which a product or biostimulant has been added has created resilience-boosting substances. We can investigate whether certain types of bacteria and fungi in the soil have occurred in greater numbers as a result of using this product. If the soil is depleted in terms of microbes, we can identify that and the grower can take action.

"All this research is giving us new insights and

### René Rotteveel: 'Developments in biostimulants are moving at breakneck speed'

**Koppert Biological Systems is also working hard to obtain a better understanding of the interaction between plant and soil. The company currently has 15 biostimulants on the market, which can be used to activate certain microorganisms. And there are more on the way. "Developments are moving at breakneck speed," says René Rotteveel.**

He is already seeing a lot of great results. "By using biostimulants, growers are improving yields and reducing losses. They can also manage with less fertiliser and fewer fungicides and insecticides. Ultimately, the aim is to achieve a more resilient crop."

### Learning curve

A biostimulant is a plant extract that acts as food for the soil. With regular soil food web and leaf sap analyses, soil microorganisms can be identified and a grower can make the necessary adjustments to retain enough nutrients in the soil and suppress pathogens.

Rotteveel admits that this is a learning curve. "It's not simply a case of adding a

biostimulant and you're done. Growers really need one-on-one guidance. You have to learn how to use them properly. Conditions are different in every greenhouse, and that makes things complicated. We know a lot about pests with legs but not about pests with no legs, such as bacteria, fungi and single-cell organisms. We are only just starting to learn about these, so we still have a long way to go."



**René Rotteveel: "It's not simply a case of adding a biostimulant and you're done."**



***New technology can analyse the leaves of a plant to identify what substances a plant produces when it is doing well and which ones it uses to make itself more resilient.***

will enable us to create a more resilient plant in the future. Because that's the ultimate goal: a robust and more resilient plant."

### Football team

To achieve this, researchers are focusing on "rationally designed microbial communities" for closed growing systems in the greenhouse horticulture sector. This is an entirely new technology which can increase resilience. "We are looking for groups of bacteria and fungi

that work together to make the plant more robust," Van Overbeek explains. "With this technology, we can easily sequence the genome of a bacterium. This gives us an understanding of what a certain bacterium does in the soil. We can predict what that bacterium will do when a particular nutrient is present, or how it will react to a particular substance. This way we can 'design' a group of bacteria that will work together to make the plant more resilient. Think of it as a football team. Eleven strikers won't win a match: to win you need the whole team to work together."

### Microbial resilience

A more resilient plant is a long-term goal, as there are still a lot of questions to be answered. "If we start now, we will be able to implement this effectively in ten years' time," Van Overbeek says. Microbial resilience plays a key role in this. "Recycling is a nice concept, but by doing that you are also recycling your problems. Growers who circulate their water, for example, not only circulate the nutrients but also the harmful plant pathogens. You have to think about that and come up with a solution. That solution lies in the microbiome."

This solution has only been known about for around five years. "For example, we also haven't known for very long that human pathogens such as salmonella and E. coli can survive in plants. So we need to look beyond

agriculture and horticulture. A more resilient plant also plays an important role in food safety."

Ultimately, the microbiome is part of the solution, he says. "It involves the whole system. Seed companies and breeders also have a role to play in plant resilience. And growers too," he emphasises. "Cultivation measures also impact on plant growth. Growers need to think differently too. For example, if you keep the soil in production for longer at 80 percent productivity without having to use chemicals, what do you decide to do? The grower also needs to start creating a more resilient system."



***Leo van Overbeek: "All this research is giving us new insights and will ultimately enable us to create a more resilient plant."***

## Summary

The plant microbiome plays a major role when it comes to boosting plant resilience. So it's not surprising that research is being done into this in a variety of ways. New technologies are enabling rapid progress to be made. Among the aspects being investigated are groups of bacteria and fungi that work together to make the plant more robust. But biostimulants also have a positive effect. The microbiome is part of the solution. Ultimately, growers themselves will also have to take action.

Practical trial on use of slow-release fertilisers with recirculation

## ‘Rather cruise control than meandering on fertiliser highway’

**Can slow-release fertilisers help reduce emissions? That is a serious consideration for phalaenopsis growers. Research and practical trials are expected to provide some answers for this cost-intensive crop. Crop manager Han-Willem Mooij has it all worked out. He can tailor his fertilisation to every variety he grows. For him, a robust fertilisation system is key.**

Pannekoek Orchideeën in the Dutch village of Berkel en Rodenrijs have been experimenting with controlled-release fertilisers since 2013 and started recirculating their irrigation water in 2015. Their system has been fully closed since the beginning of 2018. Wageningen University & Research spent several years researching the reuse of drain water in phalaenopsis, followed by research into conventional fertilisers and CRFs (controlled-release fertilisers).

An in-depth practical trial was recently set up at the orchid nursery, and results are trickling in. An appropriate opportunity, then, to speak to all those involved. Around the table are network coordinator Astrid van der Helm of Glastuinbouw Nederland, Wageningen University & Research researcher Arca Kromwijk, Riny Westdijk of ICL and Han-Willem Mooij, crop manager at Pannekoek Orchideeën.

### Need for knowledge

“The Pot Orchid Crop Cooperative has been looking seriously at the issue of reducing emissions for some years now,” Astrid van der Helm explains. Glastuinbouw Nederland had already analysed the obstacles pot orchid growers face in reducing emissions into surface water back in 2012. At that time, one third of the growers surveyed were recirculating and reusing their drain water inside the greenhouse. It was also discovered that there was a need for knowledge about reusing different fertiliser formulations.

This led to a fertiliser study at WUR in the 2014/15 season that looked at traditional (liquid) fertilisers and recirculation. “Our main aim was to dispel the fear of recirculation.



*The granules are dispensed automatically during potting.*

The influence of sodium turned out to be the biggest obstacle,” Arca Kromwijk explains. Sodium and zinc levels did in fact rise in the recirculation treatments, but with no detrimental impact on growth or the ultimate crop outcome.

### CRF or conventional fertilisation

The renewed interest in CRFs with their lower leaching and potential to reduce emissions prompted WUR to carry out follow-on research in 2016-2017, in which two treatments with

these fertilisers were compared with conventional ones.

The combination treatment of 3 grams CRF per pot and a nutrient solution containing conventional fertilisers with an EC of 0.7 was found to deliver similar crop results to the control but with 40% lower emissions.

A note of caution should be sounded with this research, however. The treatment only containing CRFs produced delayed growth in the first twelve weeks of the crop. The granules remained on top of the pot, and

because of the dry microclimate, they released too little fertiliser. This was corrected later by tapping the granules into the growing medium, after which the plants grew better. This result formed the starting point for upscaling to a practical trial.

### Automatic application

The practical trial started in 2018. The CRF used was Osmocote Season+, which has a longevity of 16-18 months. "These granules therefore last right through from the start of the crop to the delivery stage. So the supply chain and the consumer also benefit from them," Riny Westdijk explains.

Application of the fertiliser is automated at the nursery. Every plant is given 3 grams of the fertiliser via a dosing unit on the potting machine as it is potted up. The granules can then drop down into the bark during this treatment and during transportation to the greenhouse, which also creates the right microclimate for them to work properly.

During the first three to four weeks of the cycle, the crop manager added 0.7 EC conventional fertilisers to the irrigation water. Once the granules started to release their fertilisers in sufficient amounts, he reduced the EC to 0.5 - 0.6. Together with the sizeable volume of drain water that falls through the wire mesh between the pots and into the drain silo, a good, stable nutrient solution was created in the vegetative phase. An EC of 0.7 to 0.9 from drain water was added in the flowering phase, with fresh nutrients with 0.1 - 0.2 EC being added as and when necessary.

### Stable drain water

The company has an underground reservoir with a capacity of 1,200 m<sup>3</sup>. Any excess rain-water is stored underground at a depth of 40 metres. When both sources are exhausted, Mooij switches to osmosis. Drain water is



**Han-Willem Mooij (left), Riny Westdijk, Astrid van der Helm and Arca Kromwijk (right):** "All the growers are achieving pretty similar growth despite using different strategies."

disinfected with UV. As an extra insurance policy, he disinfects it with chlorine dioxide just before irrigating.

The sodium levels in the drain water silo remained stable, with an EC of 1.2. Since the beginning of 2018, the orchid grower has only had to purify two 90 m<sup>3</sup> batches of drain water in a mobile unit, out of a total growing area of 4 hectares. They haven't discharged anything since week 40 of 2018. "We take samples of our irrigation water and from the drain silo every week. These show us that the sodium and chlorine levels and the ratios of elements in the drain silo are remaining stable," Kromwijk says.

### Comparison

A unique feature of this practical trial is the collaboration between the growers in the network that was formed after the trial. Each grower is growing plants from the same batch of propagating material. They all follow their own fertilisation strategy, which means they are able to compare whether the CRFs would be an alternative to their own methods. Every time they meet up, they assess each others' plants and take measurements of leaf length and width. "Basically, we are seeing very few differences in growth despite the fact that we used different cultivation and fertilisation strategies," Mooij explains.

### Better performance

Alongside the trial, Mooij has been using CRFs throughout his nursery since 2016. The proportion of conventional fertilisers he uses has dropped to 20%. Because of the high

levels of zinc in the drain water, he keeps a close eye on the iron content and adjusts it where necessary.

"CRFs cost more than conventional fertilisers, but they last longer. Plus, it's not so easy to make mistakes with them. Because the nutrients are released more slowly, they can meet the day-to-day needs of the plant more effectively. This often leads to much lower emissions of nutrients," Westdijk says.

"My motivation for introducing them was to boost our performance. I was looking for a robust system. Meandering on the motorway isn't ideal; it was cruise control I was after," Mooij concludes. In the meantime, he has also discovered other benefits. He can dose the fertilisers differently depending on the variety. If the varieties are mixed up later in the crop cycle, he can still reap the benefits.

### Summary

Two years of research and a practical trial demonstrate that controlled-release fertilisers have a serious place in recirculation in pot orchid cultivation. Pannekoek Orchideeën has already introduced CRFs throughout the nursery. With this method, each variety can be fertilised according to its needs. Growers are cautious when it comes to implementing a new fertilisation technique because of the long crop cycle and the costly starting material.



**Han-Willem Mooij:** "My motivation for introducing CRFs is to boost our performance."



*Johan and Mirjam Desmet: "Because we don't use chelates, the carbon filter doesn't get blocked. We no longer have a problem with blockages or deposits in pipes and gutters."*

Lettuce grower Johan Desmet in Izegem, Belgium:

## 'Active carbon filter works better with iron polyphosphate fertiliser'

**Johan and Mirjam Desmet have been growing lettuces since 2003. They were among the first in Belgium to start growing them in a mobile gutter system instead of in the ground. In 2015 they started replacing the conventional HPS lighting in part of their greenhouse with LEDs. Their latest new development since early 2018 is that in half of the greenhouse they are using iron polyphosphate fertiliser instead of chelate to prevent the iron from being trapped in the active carbon filter.**

The husband-and-wife team's lettuce farm in Izegem, Belgium, was rebuilt in 2016 and now

covers 5 hectares. They grow butterhead, red and green oakleaf, Lollo Rossa, Lollo Bionda and Trio, a combination of red oakleaf, Lollo Rossa and Lollo Bionda. Depending on demand, the plants are delivered to the customer as living lettuces (with the rootball attached) or polybagged with no rootball. The lettuces are sold to customers across Europe, including many supermarket chains, via auctions.

The Desmets were the first Belgian lettuce growers to start growing under LED lighting in 2015. Now they use 45  $\mu\text{mol}/\text{m}^2/\text{s}$  HPS lighting across a third of the greenhouse and 75  $\mu\text{mol}/\text{m}^2/\text{s}$  LED lighting across the other two-thirds. "Plants grown under LED can process more light than those grown under

HPS. More light produces more growth. The extra LED lamps use more energy per surface area unit but less per unit of product."

### Switching to gutters

The Desmets started switching gradually to a mobile gutter system in 2012 and have been growing all their lettuces hydroponically since they expanded in 2016. Switching to gutters didn't come cheap, but yields are now two or three times higher depending on the type of lettuce.

There were several reasons for switching from soil to gutters. Johan Desmet: "Growing in soil in the greenhouse was causing us more and more phytosanitary problems, partly

because of the reduction in the number of chemical soil disinfectants growers can use. *Fusarium oxysporum* has therefore become a big problem in lettuce growing. You don't have problems with this disease when you grow in gutters. Because we don't have to use crop protection products, our crop is clean and is also 100% closed. We don't discharge any fertilisers."

The lettuce grower re-uses his water without disinfecting it, although he does use an active carbon filter as an insurance policy. The filter removes all organic matter, particularly exudates from the roots of the lettuce to prevent growth inhibition. What's more, the growers assume that the filter removes pathogens as well, as they are also organic. Desmet rinses his filter once a week and replaces it once every three months to prevent it from silting up.

### Iron polyphosphate

In early 2018, the lettuce grower switched over half of his nursery from chelates to Micronutri Fe, a polyphosphate-based iron fertiliser made by Prayon. This is an NPK fertiliser with a ratio of 0-42-48 with added iron. Like chelates, the polyphosphates prevent the iron from precipitating.

Dave Pinxteren is responsible for horticultural product development and application at Prayon. "Plants need iron," he explains. "An iron deficiency can be seen within a couple of hours, particularly in leafy crops. The leaves turn bright yellow. But iron is a tricky element in crops grown on substrate and water. It precipitates easily when it comes into contact with other elements. Growers have been using chelates to get iron to the plants since the 1960s."

The downside of chelates is that they are



Johan and Mirjam Desmet started switching gradually to a mobile gutter system in 2012.

organic and therefore become trapped in the pores of the active carbon filter, which prevents the exudates from being filtered out. "This makes the filter less efficient, and when the chelate content drops too low, the quantity of available iron in the nutrient solution also drops."

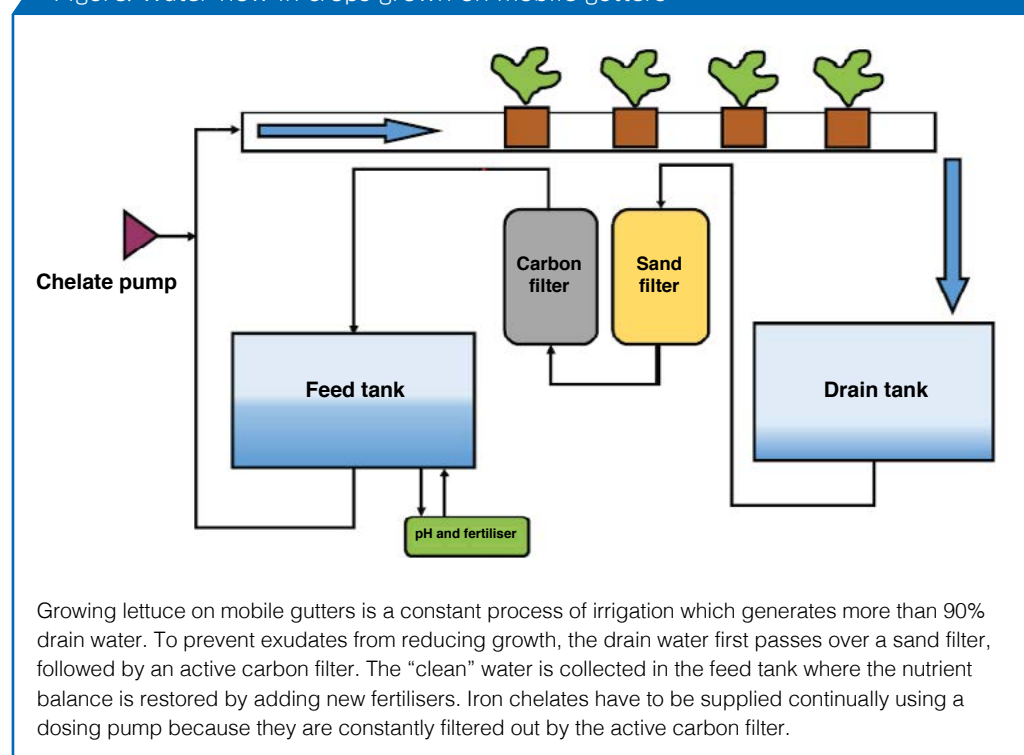
### Happy

Desmet is happy. He hasn't seen any differences in quality or yields between the sections with chelate and polyphosphate. "Seeing the crop growing well gives me peace of mind. That means that the iron is getting to the plant.

And it costs roughly the same as the conventional method. It is more expensive per ton, but you need less phosphate. Because I don't use chelates, my carbon filter doesn't get blocked. I used to have trouble with blockages in the pipes. Now I never get deposits in pipes or gutters." He plans to switch completely to the new fertiliser in the future.

Trials have revealed that all elements are absorbed better, adds Kurt Verhelst strategic account manager at the phosphate manufacturer. Polyphosphates also have an effect on calcium transport, for example. "Calcium uptake improves in lettuce and other crops. Calcium deficiency causes lesions on lettuce leaf margins which then become an entry point for *Botrytis*. Chelates can also cause leaf margin symptoms, but polyphosphates don't. That has been demonstrated in trials, but we have also seen it at Johan Desmet's nursery."

Figure. Water flow in crops grown on mobile gutters



### Summary

Johan Desmet grows several varieties of lettuce on a mobile gutter system, a third of which is lit with HPS and two-thirds with LED. He is using an iron fertiliser instead of chelates on half his crop in order to keep the iron in the nutrient solution available to the plants. The quality of the plants is unchanged, and his active carbon filter is no longer becoming clogged, as happened with the chelates.

Experience with cooling and drying greenhouse air

## Keeping latent energy inside helps save great deal of energy

**The focus of the research into semi-closed growing systems is on recovering latent energy. Cooling equipment powered by electricity combined with heat pumps brings fossil-free horticulture a step closer. The preliminary calculations are already pointing in this direction, and research into robust growing systems is expected to endorse and corroborate this theory. Some minor breakthroughs have also been made.**

Greenhouses with vents kept open in the winter are gradually becoming a thing of the past. In Next Generation Growing (NGG), strategies have recently been devised to minimise the removal of excess heat and CO<sub>2</sub>. More and more growers are controlling their climate with single and double energy screens and vertical fans. But removing moisture to lower the RH is still an important way of controlling and improving the greenhouse climate.

Loss of sensible heat is already better under control in many places, but adjusting

the RH causes latent heat to escape via the roof more often than growers would like. Latent heat is the energy that is released when water vapour condenses. So it is no coincidence that much attention is being paid to climate control equipment that allows the vents to remain closed and keeps the RH under control.

### Cooling in roses

Extensive experience has been gained with the OPAC106 Oval Pipe Air Conditioner from Lek/Habo, both in research and in the commercial setting. Back in 2010, Feije de Zwart of Wageningen University & Research (WUR) investigated the thermal transfer performance of this heat exchanger, which is mainly used to cool or heat the greenhouse air in intensively lit crops. A big advantage of this equipment is that it allows the greenhouse to remain closed more often.

In a rose research project launched at the Delphy Improvement Centre in Bleiswijk in March 2013, twelve OPACs were installed in the 1,000 m<sup>2</sup> section. Over the years, the

hybrid lighting system was gradually switched to 100% LED top light. To control humidity in this section, air can be drawn in above the screen.

Even in the first summer after the LEDs were installed, Arie de Gelder of WUR was already talking about the benefits of the well-balanced climate in the section and the positive effect it was having on quality. "Rose growing only has a future in the Netherlands if growers aim for the higher market segment. And that can only be done with top growing systems and by using energy sustainably," De Gelder said at the time.

### Electricity only

The combination of lighting, heat exchangers and a thermal pump makes it possible to design a rose nursery that uses no fossil fuels but runs exclusively on electricity. According to a study, nurseries that use 300-600 kWh per m<sup>2</sup> lighting per year bring 30-60 m<sup>3</sup> natural gas equivalents in heat into the greenhouse. That is plenty to keep the greenhouse warm in NGG scenarios. According to those calculations, this can be achieved by installing one cooling block per 160 m<sup>2</sup>. A thermal pump, a 250 m<sup>3</sup> cold buffer and a 450 m<sup>3</sup> heat buffer per hectare are also needed. The harvested heat, including the heat from the HPS lamps, can then be used for pipe heating at times when the lights are not switched on, or to level out day-to-day fluctuations.

### Excess heat in chrysanthemum

The research with the OPACs gave rise to a follow-on project entitled "The Perfect Chrysanthemum," which launched at the same research centre in early 2017. This time, a hybrid lighting system was installed. The 1,000 m<sup>2</sup> section was fitted with eight heat exchangers with a joint cooling capacity of 100 W/m<sup>2</sup>, combined with hoistable heating frames.

The researchers wanted to grow good quality chrysanthemums with 15 m<sup>3</sup>/m<sup>2</sup> natural gas equivalents of heat per year, compared with the 28-30 m<sup>3</sup> used by commercial growers. This is a 50% reduction in energy usage. After just one year they had already gone even



*The aim is to grow lit tomatoes fossil-free by actively ventilating the greenhouse air with relatively dry outdoor air.*

lower, down to 12 m<sup>3</sup>/m<sup>2</sup>. Remarkably, they were able to harvest as much as 17 m<sup>3</sup>/m<sup>2</sup> heat. Therefore, more heat came out of the section than went in, Marcel Raaphorst of WUR concluded.

### Active ventilation in cucumbers

In another project, the semi-closed greenhouse with air ducts, also known as the Next Generation Semi-Closed Greenhouse, is being further developed. In this study, the humid air is cooled with a Van Dijk Heating Active Ventilation System (AVS), which circulates actively dried greenhouse air through the greenhouse via ducts. After passing through a heat pump, the harvested heat travels to the heating pipes via water heated to 35-40°C and, in passing, also heats the air that returns into the greenhouse through the air ducts.

The rationale behind this trial is that with AVS you can buffer heat over a 24 hour period and then use it by storing it in buffers. Logically, therefore, it should also be possible to even out fluctuations in demand and supply of heat between seasons by storing the heat in aquifers. This research offers an attractive perspective for cucumber growers as it would enable them to move towards year-round production.

### Fossil-free tomatoes

Almost opposite the cucumber trial, there are tomatoes growing under virtually the same conditions in another project, “NGG Total Concept Applied in Lit Tomato Cultivation”. A hybrid lighting system has been installed here too, with some of the heat the crop needs being supplied by electric heat from the HPS lamps. According to the calculations, it is possible to harvest sensible and latent heat with a combination of an active dehumidification system and a heat pump. And, as the researchers have calculated, that is almost enough to meet the crop’s heating needs in the winter.

A closed substrate system was also set up in this trial. The tomato plants are growing on a wood fibre slab in a closed plastic box. Therefore, this trial is paying close attention to supplying and removing humidity in the greenhouse, which is an important element in NGG. This is done by regulating transpiration. Irrigation is tailored to the growing conditions by carefully matching the irrigation with the composition of the nutrient solution. If transpiration drops and the leaf surface area remains limited, the crop will extract less transpiration energy from the greenhouse air.

### Screen and vent closed for longer

A greenhouse air dehumidification system that has proved its worth in various crops is DryGair. Seventy units of this Israeli technology, which is sold through Royal Brinkman, have been installed in over forty



*A big advantage of the cooling equipment is that it allows the vents to remain closed more often. That saves energy.*

nurseries. Most of the growers opting for this technology grow low crops with a relatively low demand for energy. A lot of gerbera growers are starting to show interest. It is also being experimented with in tall crops such as tomatoes and cucumbers, but there has as yet been no major breakthrough in that area.

The two fans in the unit suck the damp greenhouse air through their cooling ribs, where the air condenses, “harvesting” the latent heat. Growers can then save energy by keeping their vents and screens closed for longer. Because the system not only removes moisture from the air but also circulates the air through the greenhouse, it creates a uniform climate, which in turn makes for more uniform plants. On top of that, the crop is more active, which also has a positive impact on resilience.

The unit has no facility for storing the harvested heat, so it is returned straight back into the greenhouse. When the unit is running, the greenhouse temperature rises by 1-3°C, depending on the number of closed screens.

And in fact that is generally a good thing because it enables the grower to turn down the pipe heating and use less gas. What is more, the dehumidification unit itself consumes less energy than the amount of natural gas saved and can be run on green electricity.

## Summary

Dehumidifying and thereby venting out latent heat has no place in a future-proof growing system. Calculations on paper show that it will be possible to grow fossil-free in the future if latent heat is recovered through cooling. The research corroborates these calculations, but the investment is high and the quality can leave something to be desired. This research is already at an advanced stage in rose, Chrysanthemum, tomato and cucumber are close behind.



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## Study of impact of biostimulants on fruit and vegetables

**Biostimulants are among the natural products that claim to improve the general health, vitality and growth of plants and protect them against infections.**

The positive impact of biostimulants has been known about for many years. However, these products are rarely used in standard crops because many growers are unsure how they work and how to use them.

We are currently preparing a project in which we will

evaluate various biostimulants in order to better understand their impact on the quality and quantity of fruit and vegetables. In it, we will look at variables such as improvements in nutrient uptake, nutritional values and flavour. Improvements in soil conditions and the development of naturally beneficial microbes could also be included. Interested companies, growers or suppliers of biostimulants should contact Yaite Cuesta or Caroline Labrie.



Text: Yaite Cuesta Arenas

## Sustainable and resilient strawberry cultivation system for 2030

**Despite all the efforts to make strawberry cultivation greener, some persistent obstacles still remain which mean that chemicals are still needed for many crops.**

It is therefore time to investigate what the ideal sustainable cultivation system would look like if we could start again from scratch. Over the past two years, we have been developing a sustainable, robust and resilient strawberry cultivation system for 2030 on behalf of the Dutch Ministry of Agriculture, Nature Management and Fisheries and in collaboration with the sector.

The vision for 2030 is based on growing strawberries from seed, with both propagation and production

taking place in protective greenhouse conditions. In this system, the crop starts off clean (from seed) with much lower exposure to pests and diseases, so there are more options for biological controls. In addition, the grower can use the greenhouse facilities to optimally steer the crop; hence the choice of stonewool as the substrate. It is therefore based on prevention and optimal growing conditions.

This new system is further reinforced by selecting less susceptible varieties, resilience-enhancing measures and biological controls. We have been testing a prototype of this redesign in our Bleiswijk trial greenhouses since December 2019.



Text: Ellen Beerling

## Can lily bulb and flower growth be controlled with light spectrum?

**The distribution of nutrients in lily from leaves and bulbs to bulbs and flowers changes depending on the plant's development stage. The switch that directs the assimilates from where they come from (source) to where they are used (sink) is controlled by light, among other things.**

At the planting stage the shoot is a strong organ that uses the reserves in the bulb. Later on, the bulb becomes a sink and extracts the sugars produced in the leaves. When the plant flowers, the bulb becomes a source, along with the leaves. After flowering, the bulb once more becomes a sink organ. Switching from source

to sink activity and vice versa is triggered by different signals, such as molecular regulators, hormones and light. We are developing a cultivation system (the Vital Lily Cultivation Project) to improve and accelerate the growth of small lily bulb plant material.

In one experiment, we tested different light spectra in the six weeks after planting. Although the differences in bulb growth were insignificant, blue light improved above-ground growth. We therefore want to test whether blue light can molecularly inhibit lily bulb growth while the flowers are growing and whether this results in more and larger flowers.



Text: Natalia Moreno Pachon

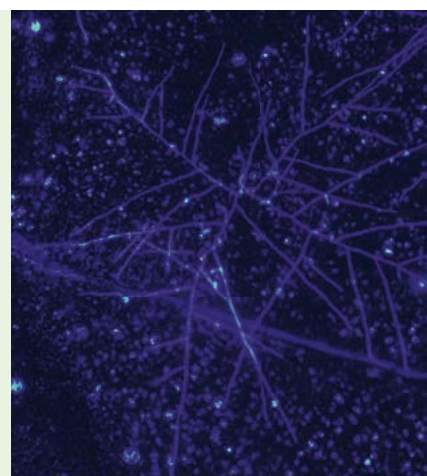
## Early detection of powdery mildew in tomato

**Hyperspectral and multispectral imaging are promising techniques for plant disease monitoring. Up to now, only general stress indicators have been used for this purpose.**

In this project we are linking imaging to physiological plant reactions to powdery mildew infection in tomato. We take multispectral images of both infected and non-infected leaves at the various stages of infection. To determine the strength of the infection, we take microscopic images using confocal and fluorescence microscopy. The photograph shows a fluorescence microscopy image of powdery mildew

infection in tomato ten days after inoculation.

In addition, we determine the plant's reaction to mildew infection by measuring antibodies in the form of total phenol levels and the amount of hydrogen peroxide formed. Then we establish whether these spectral and physiological datasets correlate with each other to produce patterns that will enable us to detect early mildew infection before the hyphae are visible. This is an investment project of Wageningen University & Research with the collaboration of three teams: Plant Health, Plant Physiology and Horticultural Technology.



Text: Kirsten Leiss



Cluster tomato grower Paul Zwinkels: “The new fertiliser works really well. The numbers in the samples haven’t changed.”

Low-sodium phosphate fertiliser with cleaning effect

## Constantly fine-tuning tomato fertilisation keeps system clean

**The tomato plants at P. and R. Zwinkels’ cluster tomato nursery in the Dutch town of Wateringen look fresh and vigorous. The trolleys with 5 kg boxes filled with freshly harvested, rosy red cluster tomatoes make regular trips to the shed. The growers focus a lot of attention on irrigation and fertilisation. Last autumn they trialled a new, low-sodium phosphate fertiliser with a cleaning effect.**

The family business was originally based in the centre of Wateringen. When they had to relocate to make way for a housing development in 2004, they moved to their current 4.5 hectares premises on the edge of town. Paul Zwinkels took over at the helm two

years ago and runs the business with his son Joost. They sell their tomatoes via The Greenery. They grow Tourance, a medium-sized cluster tomato, specifically for Dutch supermarket chains Jumbo and Plus.

### Water

Sustainability permeates every aspect of the company, which uses biological controls wherever possible. They only use 0.6 m<sup>3</sup> of natural gas per kg of tomatoes and recirculate 100% of their fertilisers. Using good irrigation water and pure fertilisers enables them to reuse all their water.

In terms of irrigation water, Zwinkels has learned a lot over the years and has made some big steps forward, reducing their discharge rate to virtually zero. It bothers him that this

is not sufficiently appreciated. “I come from the time when we irrigated with mains water and water from ditches. Now we use rainwater. We have a 10,000 m<sup>3</sup> reservoir. In the relatively dry period from May to the end of July we supplement our irrigation water with reverse osmosis water.” Zwinkels disinfects his drain water with a low-pressure UV disinfection unit.

### Standard phosphate fertilisers

Just like other growers, Zwinkels has an A and B tank for dispensing fertilisers. Wherever possible, he uses low-sodium fertilisers to prevent sodium build-up. The feed water that goes to the plants is dispensed from a mixing tank with solutions from the A and B tanks, up to 40% “clean” drain water and clean

irrigation water. "Preventing precipitation in the system and ensuring the elements are in a form that is available to the plants are things I constantly keep an eye on."

Marco Molenaar is fertiliser product manager at Haifa. "The downside of standard phosphates is that they react with elements like calcium and magnesium and then precipitate in the system. That not only creates mineral build-up in the pipes but also impacts on availability to the plants. This build-up also causes irregular application in the greenhouse, which ultimately affects yields."

### Mineral build-up

Polyphosphates don't have this problem. They are made up of phosphate chains. They solubilise precipitated elements such as calcium, magnesium, potassium and various trace elements. "Using polyphosphates is the only way to prevent and fix mineral build-up in the pipes. They transport the precipitated elements with their chains," Molenaar explains.

"Growers add a lot of calcium into the solution combined with a high EC and, occasionally, a high phosphate dose, particularly at the start of the crop. But that quickly forms calcium phosphate, and you then have to get the system clean and keep it that way for the rest of the year."

"In practice, we always recommend a combination of polyphosphates and standard phosphates," Horticoop fertiliser product manager Ferry Camman advises. A dose of 0.5 mol polyphosphate is enough to produce this cleaning effect. The rest of the phosphate you give can consist of standard phosphate



Marco Molenaar (left) and Ferry Camman ran a pilot with the new fertiliser.

fertilisers such as monopotassium phosphate. "But there are ground rules that need to be followed when you use polyphosphates. For example, the B tank needs to be acidified by adding the polyphosphate and you have to watch the order in which you administer the fertilisers."

### User-friendly solution

Zwinkels has since gained several years' experience with VitaPhos-K combined with standard phosphates. He knows how to dissolve this fertiliser in the B tank, which not everyone does. The risk of making mistakes prompted Horticoop to ask fertiliser supplier Haifa whether they could develop a user-friendly product.

The result they came up with together was GrowClean. This product is formulated in such a way that the phosphate, together with the other elements, remains in solution better and therefore remains available to the plant. There is also no need to add acid to the tank with this new product. "Also, it is a low-sodium product, so there is less accumulation of undesirable salts. This benefits the uptake of other elements the plant needs," Molenaar explains.

### Less risk of mistakes

The new product contains the elements  $H_2PO_4$ ,  $K_2O$  and  $NO_3$ . The recommended dose for achieving the cleaning effect is to add 0.5 mmol polyphosphate per every 1 mmol of phosphate. That way, the full dosage of phosphate can be given with the new fertiliser for many crops.

Before launching the new fertiliser, the manufacturer produced a trial batch which it piloted at the Zwinkels nursery. "The new fertiliser worked really well. The numbers in the samples were unchanged and we needed to add less acid. The big advantage is the fact that it is very easy to use and there is less risk of mistakes," the grower says, after testing the new product.



Zwinkels grows medium-sized vine tomatoes of the Tourance variety for Dutch supermarket chains Jumbo and Plus.

## Summary

Standard phosphate fertilisers have the property of forming compounds with calcium, magnesium and iron. Polyphosphates are capable of solubilising precipitated elements and thus cleaning the system. Tomato grower Zwinkels therefore adds some polyphosphates to his fertiliser mix to prevent problems. A new product was piloted at his nursery.

Yellow and blue sticky traps not always ideal

# Knowing how insect pests see means better monitoring and trapping



*A yellow sticky trap against a green background could work better than a yellow trap against a blue background.*

**How do Californian thrips and the European tarnished plant bug see their environment, and how can we use that knowledge to create more visible and more attractive traps? This question is central to research being conducted by Wageningen Plant Research, which is aiming to improve monitoring and trap more insect pests. The initial results of the research show that knowing more about what insect pests actually see does in fact offer scope for developing more efficient traps.**

A lot is set to change in the greenhouse in the years ahead. Not only on the energy and lighting front, but also in terms of crop protection. Integrated Pest Management is gaining ground, and monitoring is a crucial part of that.

As far as the latter is concerned, there is potential for some big steps forward, says entomologist Rob van Tol of Wageningen University & Research. "The yellow and blue

sticky traps that growers currently use don't always work optimally. They are fine for monitoring but not for trapping insects. What happens is that you only trap insects that happen to collide with them. To improve monitoring and to be able to trap more of these creatures, we need to find out more about how insects see. We can then use this knowledge to develop better and more efficient traps."

## Thrips and bugs

Van Tol spent the last two years researching in this area, concentrating on two pests: the Californian thrips and the European tarnished plant bug. "We decided on the Californian thrips because it is difficult to control in the greenhouse," he says. "Growers have to constantly measure the infestation pressure with blue or yellow sticky traps and gear their use of natural predators towards that. But that doesn't always work and they sometimes have to resort to chemicals as well. As the range of chemicals growers can

use is constantly shrinking, that is becoming more and more difficult. Developing a better trap system could help trap more thrips and bring the infestation down to a manageable level. Then the natural predators could keep the situation better under control and there would be less need to reach for the chemicals."

The problem with the European tarnished plant bug is a completely different story, the entomologist says. These bugs fly into the greenhouse in the spring and summer and directly pierce the flower stems and ovaries of fruiting crops like aubergine. "This leads to fruit drop or deformed fruits. There isn't much point in using natural predators because there isn't enough time for them to attack the incomers. Systemic insecticides are an option, but authorisations of these products are currently under a lot of pressure. The only alternative to chemical controls is to trap or deter the incoming bugs. But you need the right kinds of traps to do that."

## Reacting to light colours

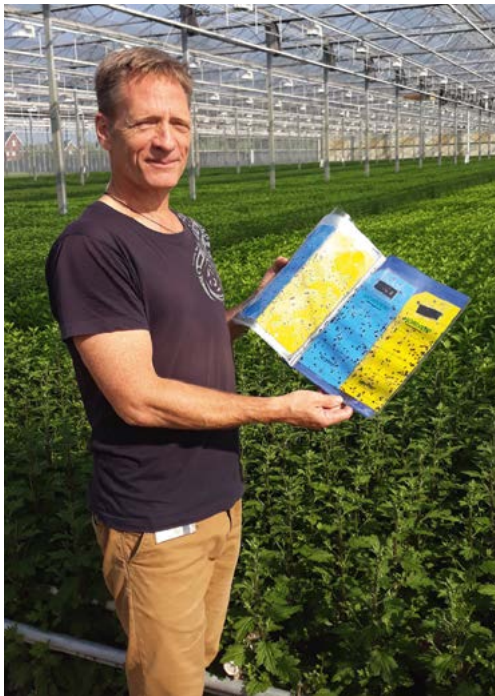
According to Van Tol, then, better traps could play a major role in resolving these problems. They could help delay the build-up of thrips, thus enabling natural predators to do their job better and catch the European tarnished plant bug before it can start causing damage.

To collect information on how to improve the trap systems, for the past two years the research being conducted at Wageningen Plant Research has focused on establishing how thrips and European tarnished plant bugs see their environment. “In our research we specifically observed how thrips and other insects find their way under different LED light colours,” Van Tol says. “We have now tested the whole of the light spectrum – from UV to infrared – on thrips and the European tarnished plant bug, and we know exactly what colours these pests are and aren’t attracted by.”

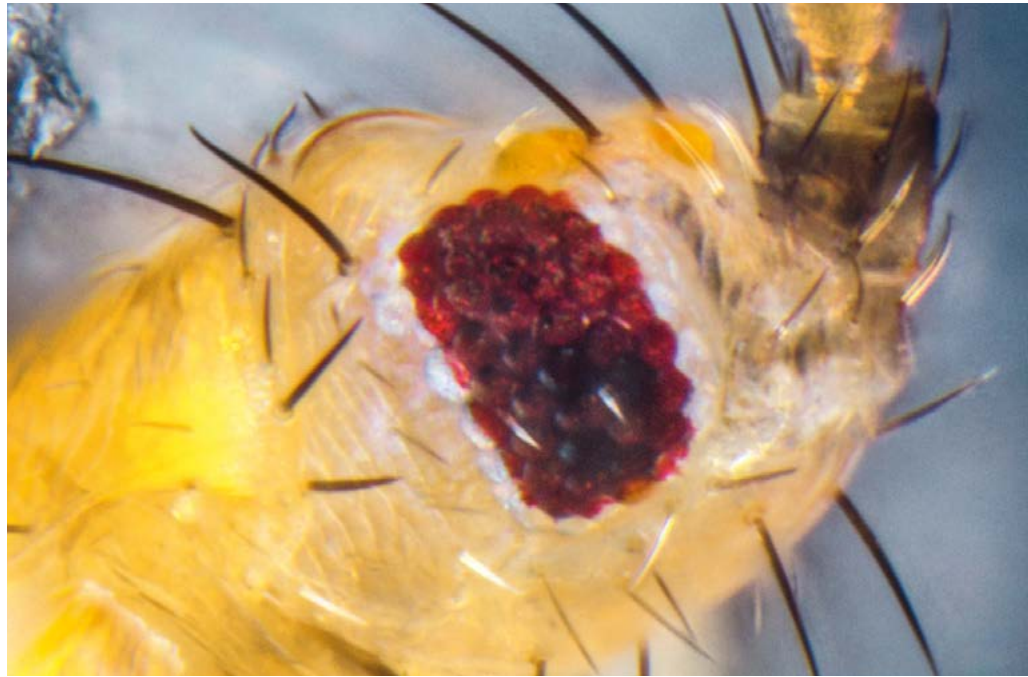
The research shows that the European tarnished plant bug is strongly attracted by one specific colour. Californian thrips seem to respond well to various LED light colours. “Yellow LED light and UV-A light achieve the best results in our set-up, while blue LED light does less well. That’s quite the opposite to what you see in practice. We don’t yet know why this is. Among other things, the genetic background of the thrips seems to determine its preference for blue or yellow LED light, just as it determines whether or not a thrips is hungry. We want to do more research into this.”

## Colour contrast important

Research also shows that UV light is of crucial importance for thrips and other insect pests. “Insect pests need UV-A light to find their way and to find plants or sticky



**Rob van Tol:** “Knowing more about what insect pests actually see offers scope for developing pest-specific traps.”



**The insect eye consists of lots of “mini-eyes”. Researchers are determining what colours these mini-eyes can see and which direction each one can look in.**

traps,” Van Tol says. “Colour contrast is also important – even more so, in fact, than the colour of the trap itself. A yellow sticky trap against a green background may work better than a yellow trap against a blue background, for example. We want to find out more about this, especially the right colour combinations and patterns. This will therefore be a central pillar of the follow-up research we will be running until 2021.”

## Preferences

In the follow-up research, the WUR scientists will also be looking closely at the eyes of the thrips and European tarnished plant bug in collaboration with British and Swedish researchers. “The insect eye consists of thousands of ‘mini-eyes’. In our research we are determining what colours the mini-eyes can see and which direction each one can look in. Then we will use this data to make a model of how these insects see their environment and therefore the traps. This will enable us to further refine the design of new traps to make them more efficient and easier for the insects to identify.”

## Extending to other pests

Although this research has not yet come to an end, Van Tol says they have already gathered a wealth of information on the vision of the Californian thrips and the European tarnished plant bug and what needs to be done to make traps more visible. “Based on this information we have already produced an initial design for a trap for the European tarnished plant bug. This trap, which is in the specific LED colour that attracts these bugs, traps more than 75% of them. The trap is currently being tested in mini-greenhouses and we hope to be rolling it out in the commercial setting soon. We are

also testing a number of new LED light traps for thrips.”

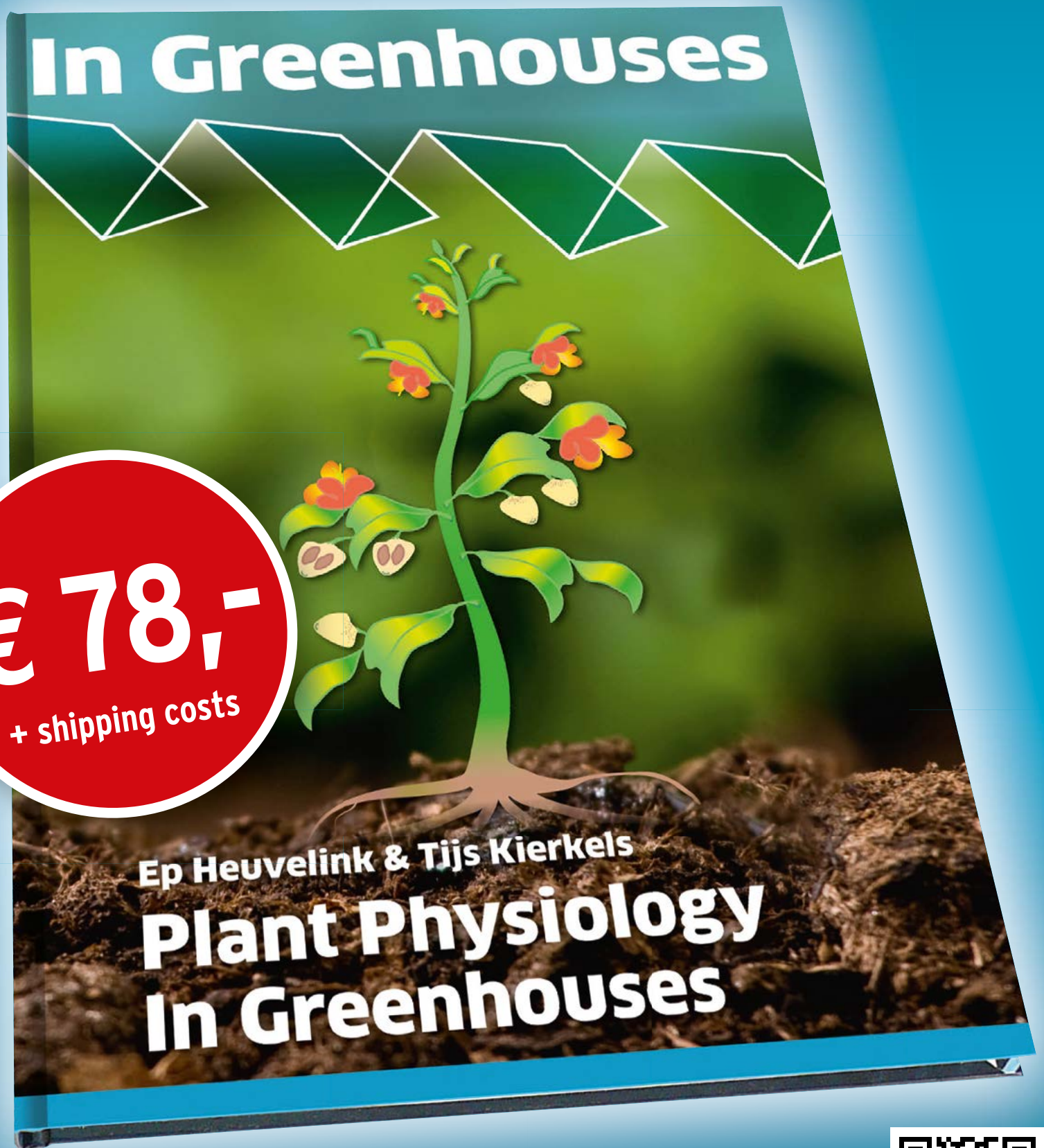
## Attractive traps

According to the entomologist, the results of the research so far are leading to the conclusion that knowing more about what insect pests actually see offers scope for developing pest-specific traps – traps that are attractive and clearly visible to certain pests. It is hoped that these traps will help make the detection and trapping of insect pests such as thrips and the European tarnished plant bug more efficient, including in new greenhouses with other types of lighting. “What’s more, with this knowledge and the research setup we have developed, we can quickly and easily test the colour preferences of other insect pests. Another benefit of more efficient trap systems is that growers may soon need to use fewer traps and can reduce the volume of plastic waste the traps generate. They also cut down on labour. But it will still be a challenge to make the new trap designs practical and affordable for the grower,” Van Tol concludes.

## Summary

To improve monitoring and to enable more insects to be trapped, it is important to gather more information about how insects see. A special study by Wageningen Plant Research is working on this. They are focusing on two pests: the Californian thrips and the European tarnished plant bug. The information they have gathered so far on these insect pests’ vision offers opportunities to develop more efficient traps.

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## Preventive maintenance extends life of vegetable grading machines



*With proper maintenance and timely replacement of the electronics, a grading machine should last for a good 15 to 20 years.*

**A fruit and vegetable grading machine sees to it that all products of the same size, weight and/or colour land up together. Another option is internal and external quality control. Grading generally concerns sweet peppers, tomatoes, cucumbers and courgettes. The choice of grading options depends on market requirements. In all cases, good maintenance will ensure reliable measurements and will keep the mechanical part of the grader running for longer.**

The simplest form of grading machine only grades according to weight. About 20 to 25 percent of growers choose this option. More than 70 percent of growers grade by colour and size. The product then travels past a camera unit with two types of cameras. Less than a handful of growers in the Netherlands use a grader that also selects on the basis of external and/or internal quality. Growers who supply a market that demands superior quality, such as the UK retail market, invest in this high-tech equipment.

### More angles

To differentiate the external quality you need a higher quality camera than the standard version, which looks at the product from more angles. A better camera will enable you to identify anomalies such as scorches on sweet peppers or cutting damage on tomatoes, for example.

If internal quality is also a criterion, you can add a separate unit with a spectrometer. The measured spectrum then gives you a statistical indication of factors such as the ripeness of a tomato or internal rot in a sweet pepper.

Growers who have to grade a large volume of product quickly, accurately and cheaply, such as those supplying Aldi or Lidl, tend to invest more money in the mechanical part. They opt for a turnkey project which not only grades the products but also packs and palletises them ready for shipping to the customer.

### Checking prevents problems

Whether your grading machine is simple or advanced, it is important to check its general status daily. The products pass along a carrier.

Is this still in good condition? Before you start, run the machine empty for a while and check that the cups are still showing the correct tare weight to prevent faulty measurements.

Is the camera still producing good quality images? Take a few pictures of products to check that the colour and size are still showing nicely. Are the sensors still working properly? If you skip this routine, you run the risk of discrepancies occurring during the grading process.

Check all moving parts weekly. Inspect the bearings and chains and lubricate them if necessary. Blow the machine clean with air. Certain components have a limited lifespan. A lamp for measuring internal quality has a limited number of operating hours. Machines usually come with a checklist that tells you when the bulb needs to be replaced.

### Annual checklist

The machine needs a complete check every year. This should preferably be done by a service engineer from the supplier of the machine, but an on-site technician should also be able to do it.

1. Ascertain which parts need to be replaced using a checklist. Ultimately it is up to the owner of the machine to decide whether to replace parts preventatively to avoid downtime. If downtime is not a problem, replacement can be postponed.
2. Check the quality of the camera images and electronic signals.
3. All machines have a computer system. Is the hard disk still working properly? Have the computer system log analysed by the machine supplier's helpdesk. This will indicate whether certain parts are faulty or causing problems. Have them replaced if necessary.
4. On the mechanical side, with proper maintenance a grading machine should last for at least 15 to 20 years. However, electronics become obsolete sooner, so computers should be replaced after 7 to 10 years. Machines with old electronics can be sent for a complete electronics upgrade to the latest hardware and software. Your machine will then last for many more years. <



Martin Feteris: "I began to realise that we couldn't continue along the same lines as far as energy usage is concerned."

'Creating uniformity and peace of mind – that's what it's all about'

## Anthurium grower halves energy usage with moisture-permeable screen

**Continuously striving to improve, that's what characterises Martin Feteris. And it's no different when it comes to saving energy. That's why for the past few years the pot Anthurium grower has been getting to grips with Next Generation Growing. As a result, he has managed to slash his energy usage by half and achieve better cropping results at the same time. Although his success is determined by a range of factors, the moisture-permeable screen cloth he bought plays a key role in this.**

Feteris runs a 2 ha pot anthurium nursery in the Dutch town of Hedel. His greenhouse,

which was built in 2009, is equipped in line with the latest insights. "Optimising cropping and processing was our top priority when we were building it," Feteris says. "Among the kit we invested in were camera grading, a labelling machine and a fully automatic spray/irrigation boom. We also have a closed watering system. Plus the nursery is designed to grow as many plants per square metre as possible."

### Uniform greenhouse climate

Very soon after the greenhouse was completed, the grower started applying the principles of Next Generation Growing. "I began to realise that we couldn't continue along the same

lines as far as energy usage is concerned. Not only from a social point of view, but also because more and more customers are asking for sustainably grown products. And gas will only become more expensive in the future." So the grower took a course in Next Generation Growing and immersed himself in the book of the same name. "The nice thing about this approach is how straightforward it is: most of the aspects are extremely logical."

Feteris started to apply the principles of this new growing method in various ways in his business. The main objective is to create a uniform greenhouse climate, so he invested in Nivolators – fans that provide vertical air circulation, mixing the air at the top and

bottom of the greenhouse. This creates a more even temperature and relative humidity and optimises the distribution of CO<sub>2</sub> through the greenhouse.

### High insulation value

The grower's two screen cloths are another important piece of the jigsaw in his new growing strategy. The bottom one is an energy screen from the Belgian supplier Phormium. "We installed this screen in 2010 as part of the new build," says Feteris. "To save energy, we wanted a cloth with a high insulation value but that also lets through as much light as possible. This screen fitted the bill perfectly: it only shields 11% of the incoming light. Another advantage of these screen cloths is that they last a long time. Normally a screen needs to be replaced after six years, but we have had ours for nine already."

According to Arjan van der Veer, Sales Manager Netherlands at Phormium, the long lifespan has everything to do with the fact that the cloths have a special woven structure. "This makes these screens more durable and stronger."

### Screen for moisture removal

To begin with, Feteris's used a shading cloth with a screening percentage of 77% on top. He replaced this last year with the PhormiTex Lumina 60, a new moisture-permeable cloth from his supplier. "To get rid of the moisture, we started off by opening a gap in the screens. But that was far from ideal, mainly because of the cold draught onto the crop. It also didn't create an even greenhouse climate. Then they came up with this new cloth. It contains special acrylic yarn which is ideal for removing moisture," the grower explains.

Another aspect that won him over was the fact that this screen defuses the light, which



*There is an energy screen and a shading screen in the greenhouse.*

allows him to let more light into the greenhouse. "My old screen had aluminium strips, but this one has white ones. They scatter the light and prevent sunlight from falling directly onto the plant, which anthuriums don't like. Because the moisture-permeable screen diffuses the light, we can allow extra light in. We have gone for a screening percentage of around 60%, and I reckon the plants are getting around 10% extra light. This is having a positive impact on the crop: we are having much less of a problem with plants not flowering now, for example."

### Closed for longer

Despite the fact that the screen is closed, Feteris says that the installation value of this screen is slightly lower than the cloth he used before. "But because it lets more light through, we can leave it closed for longer. I'm very hopeful that these aspects will cancel each other out so that the energy savings will be the same on balance. We hope to get a better picture of this soon."

Besides the cropping benefits, the new screen is also helping Feteris to optimise his Next Generation Growing strategy in practice, he says. "We can keep the screen closed and dehumidify at the same time. And very evenly, too, as the screen takes up the entire area of the greenhouse roof. That's one advantage over 'local' dehumidification solutions."

### Energy usage halved

Although the screen plays a crucial role in creating an even climate in the greenhouse, other factors also contribute, the grower

points out. "The vertical fans, the fact that we ventilate above the screen, it all helps. Also the fact that we grow on ground cover with PhormiSol AquaFlux underneath. This polyamide based fabric, which also comes from the same manufacturer, prevents dry or wet patches on the crop floor so it also plays a part in creating uniform conditions."

The strategy outlined above is bearing fruit. Feteris has managed to slash his gas usage by half over the past few years. "The more uniform the climate, the less stressed the plant gets and the less disease pressure we have. You can then steer it better and you have fewer hoops to jump through. In terms of energy, for example: we avoid peaks and troughs so we save money. Having a more even greenhouse climate also encourages the plants to grow more quickly. In other words: creating uniformity and therefore peace of mind – that's what it's all about!"



*Arjan van der Veer (left) and Martin Feteris: "The special woven structure has advantages."*

## Summary

Pot anthurium grower Martin Feteris has actively embraced Next Generation Growing and is aiming to achieve a uniform greenhouse climate. He has invested in vertical fans and has installed two screens. Last year the grower bought a new, moisture-permeable screen cloth. This strategy is bearing fruit: he has cut his energy usage by half and the crop is benefiting as well.

**van Dijk** heating

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## PRODUCTNEWS

### String machine cuts 2000 strings per hour



At the start of every new growing season, greenhouses are kitted out with many kilometres of string for supporting high-wire crops. To make it easy to attach all that

string, Steenks Service of De Lier in the Netherlands has developed a string machine. With almost 500 units of the latest model sold, it is a great success, according to Steenks.

These string machines are suitable for use with cucumber, sweet pepper, aubergine and courgette crops. They can be mounted on any type of pipe rail trolley and allow workers to quickly cut the string to length. When the string is hung on the wire, it is automatically cut off and a new one of the same length is delivered, making it quick and easy for workers to hang the strings.

This string machine cuts up to 2,000 strings to the same length per hour. It can handle a wide range of string types and thicknesses, it has a sharp, high-grade steel string cutter, it works fast and it is maintenance free. All string machines are supplied with a post and two support feet as standard.

**More information:** [www.steenks-service.nl](http://www.steenks-service.nl)

### Ellepot launches new material for organic production



Ellepot Organic 2.0 is the first product to be launched by this manufacturer in a brand new range of propagation materials. This

new paper consists of 100% fully compostable and biodegradable materials. Based on renewable wood fibres from FSC-certified forests and other control sources, it is 100% soil degradable. The product ensures good root development, resulting in faster growth and healthier plants, and is suitable for all plant propagation, field planting and organic production.

With a decomposition time of 6-8 weeks, this product is ideal for growers of organic crops and crops with a shorter propagation time. The new product is approved for organic crops in Denmark, Sweden and Canada.

**More information:** [www.ellepot.com](http://www.ellepot.com)

### New LED fixture from Oreon



Oreon recently launched its new LED fixture, Monarch. The new lamp produces a light output of up to 3100  $\mu\text{mol/s}$  with energy consumption

of 1010W. This makes it the most compact and most powerful LED fixture on the market, according to the supplier.

All Oreon's Dutch Powerhouses operate with water cooling technology. The high light output means even more light and fewer fixtures in the greenhouse. Replacing a 1000W HPS fixture with the new LED lamp provides the grower with around 60% more light on the crop. This latest LED fixture has all the characteristics of its other lamps: the robust design, the glass LED cover, the low operating temperature and easy maintenance.

**More information:** [www.oreon-led.com](http://www.oreon-led.com)

### Autonomous transport system with no induction wiring



Metazet FormFlex recently presented its new autonomously operating M-Flex system. This system is a derivative of the well-known M-Track system that allows internal transport systems to be automated via induction wiring. But the main difference is that the new variant doesn't require the use of induction wiring at all. The system works fully autonomously and is therefore highly flexible when it comes to designing and adapting the required routing. As no further adaptations need to be made to the working environment, the system is also quick and easy to implement.

The M-Flex system uses a unique navigation method to find its way around the greenhouse. It therefore no longer needs recognition points in the vicinity and performs extremely well even in a continuously changing environment.

**More information:** [www.metazetformflex.nl](http://www.metazetformflex.nl)

### Pellikaan launches new crop hook



Pellikaan Gewasklemsysteem has recently launched PlanthooQ Ultra Light, a brand-new crop hook that delivers a 10% light gain. This has been demonstrated in research by the Warsaw University of Life Sciences, according to the supplier. The new crop hook has an even smaller diameter than the previous version and also comes with a light-reflecting coating.

The new hook is available in different lengths and is part of the Qlipr system. Two stainless steel clamps are fixed onto the hot-dip galvanised PlanthooQ to allow the plant to grow. Burlap rope and plastic clips are therefore no longer necessary, making bundles of rope blocking light at the top of the crop a thing of the past.

**More information:** [www.pellikaanq.com](http://www.pellikaanq.com)

### Electric bio-hopper



Weterings Machinery has been producing its Bio Hopper XL for clearing out all kinds of crops, substrates and ground covers for many years. Now this machine

is also available in an electric version, so growers can clear out waste materials from the greenhouse without having to worry about emissions.

The clearing machine rolls up the transport mats, pulling the waste materials to the central aisle. The materials then fall onto a conveyor belt which transports them to the container or deposits them on the concrete path. The Bio Hopper is equipped with safety doors that prevent the canvas from being fully rolled up. The canvas can only be rolled up when the doors are fully open. The conveyor belt is reinforced with steel crossbars which protect the belt from accidental damage.

**More information:** [www.weterings.nl](http://www.weterings.nl)

### Easy 1-on-1 HPS to LED replacement



Whatever their choice, Philips GreenPower LED plug-&-play toplighting enables growers to easily switch to LED by simply installing the compact grow light on their existing trellis. For new greenhouses, installation is made even more straightforward with easy-to-fit brackets. The universal design of this system allows growers to equip their greenhouse with full LED or change their current setup to a hybrid LED and HPS lighting system. The new lamp uses 50% less energy while matching the light output of the existing 1000W HPS grow light.

Growers can choose from a wide variety of modules. The high-output module provides up to 2650  $\mu\text{mol/s}$  of light to boost results for light-loving crops. This allows growers with a CHP system to make maximum use of their power.

**More information:** [www.signify.com](http://www.signify.com)

### Optimising growing strategy with harvest forecast model



For many years, growers across the world have been struggling with two questions: How high will production for the following weeks be, and what does my

labour scheme need to look like? In the past, these questions were answered using manual predictions, but the results often missed the mark by many tens of percent.

The protected horticulture sector has recently been seeing exponential growth in sensor-generated data, giving rise to a more statistical approach in data-driven growing. Smart data analysis is key in producing more precise forecasts and more cost-effective business models. An important step in the digitalisation of tomato production is the harvest forecast.

Hoogendoorn Growth Management has produced a harvest forecast model with an accuracy of between 80% and 94%. Using this model, growers can grow more systematically, which allows them to optimise their cultivation strategy and harvest at the right time.

**More information:** [www.hoogendoorn.nl](http://www.hoogendoorn.nl)

### Ultrafiltration system Mienis Water

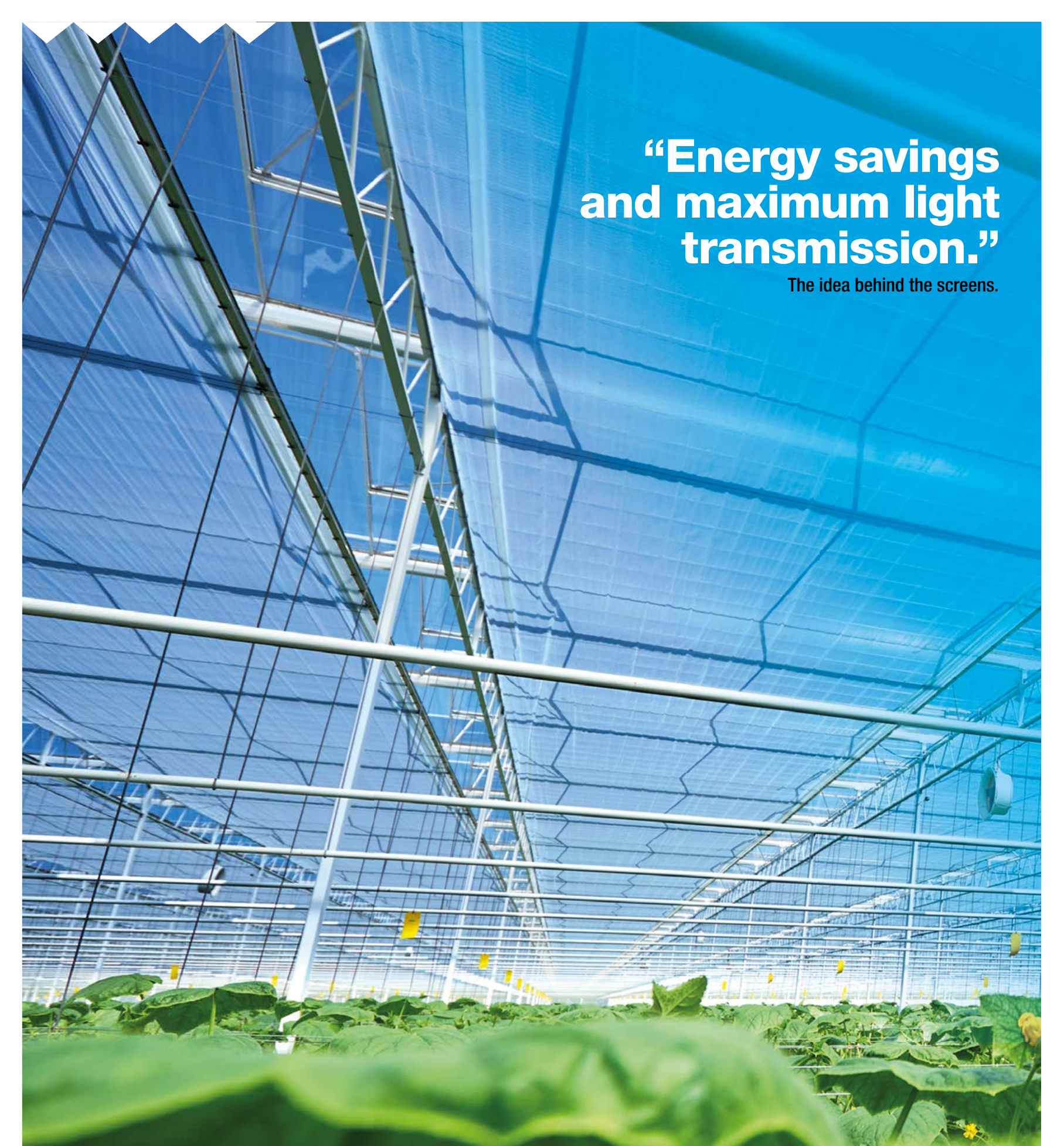


The safest way to treat surface water and drain water is ultrafiltration (UF). It takes out all organics, nematodes and fungi. Even viruses up to log 5 and bacteria up to

log 8. It is the only technic that can recycle the iron chelates in the drain water.

Up to now the downside of this technology was the fouling of the membranes. Mienis Water's new UF system is robust and very low on maintenance. Jochum Genuit, technical director: "We have now for years systems running by growers of cuttings, cucumbers, tomatoes and by breeders. The systems have a fully automatic cleaning system so the only maintenance on the system is adding the chemicals like peroxide, acid and leach."

**More info:** [www.mienis-water.nl](http://www.mienis-water.nl)



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