Aligning energy and root zone management strategies for sustainable tomato cultivation

GRODAN, as partners in a project 'The New Way of Growing' with GreenQ at the Improvement Centre in the Netherlands, are investigating innovative cultivation techniques aimed at making tomato production more sustainable. In this, the second of five articles in a new series for *Practical Hydroponics & Greenhouses*, GRODAN Crop Consultant ANDREW LEE and PIET HEIN van BAAR, Head Grower at the Improvement Centre, describe the way energy and root zone management strategies were aligned to realise maximum production and quality with a reduced environmental footprint. Part 2 describes important factors related to crop steering from flowering of the third cluster to first harvest.
The New Way of Growing

The concept behind ‘The New Way of Growing’ is to reduce the amount of fossil fuel used in the production of greenhouse tomatoes and thereby make the cultivation more profitable and at the same time, more sustainable. The goal at the start of the cultivation was to realise a production of 63.0 kg/m² using 22-25m³ natural gas (note the average energy consumption required for producing a tomato crop in Netherlands is 40m³). Energy reduction was achieved by using moveable energy screens and a process of active dehumidification.

In the first article (PH&G, May 2013) we followed the crop until the third cluster was flowering. The balance and cluster quality by this stage was good and the stated aim moving forwards for the researchers with respect to the cultural strategy was to achieve as much energy saving as possible without compromising what they had already achieved. During this period of growth the plants rapidly gained leaf area, which combined with the increasing, yet still cold, outside temperatures meant that energy saving had to be balanced with humidity control as transpiration increased. Piet Hein explains: “the basic screening strategy, which we implemented at the start of the cultivation, was still active. The XLS 10 REV opening first followed by the XLS 10 REV H2no (Figure 1). “Active dehumidification also costs energy (electricity): now we are in a situation where we need to reach a balance between humidity control and the number of hours we screen,” adds Piet Hein.

| Mean outside light levels per week / 6 year ave. (J/cm²) for period week 7-15 | 5699 / 6452 |
| Mean outside temperature / 6 year average (°C) for period week 7-15 | 3.0 / 7.3 |
| Mean 24 hour greenhouse temperature (°C) for period week 7-15 | 17.9 |
| Total screening hours: week 2-15 Double XLS 10 REV | 1367 |
| XLS 10 REV H2no | 1362 |
| XLS 20F Harmony REVOLUX | 1.5 |
| Total Energy consumption (m³ gas) week 2-15 | 15.0 |
| Total applied irrigation (l/m²) week 2-15 | 138.6 |
| Total drain volume (l/m²) week 2-15 | 40.8 |

Table 1: Overview of the outside climatic conditions, screen hours and water use from flowering of the third cluster (week 7) to first harvest (week 15).

However, one thing that the trail has demonstrated so far is that with active dehumidification the humidity deficits in the greenhouse are higher in the period around sunrise compared to traditional method of vent and heat. The energy screens are now allowed to gap 3% if the humidity becomes too high within the range 2.0 to 1.3. The main concern for the researchers is Botrytis infection and the impact this would have on total production. Consequently, the crop is being monitored daily.
The second cluster pictured in week 15 showing evenly sized and coloured fruit, an indication of adequate speed and strength.
Below: Figure 1: Screen shot from the Priva computer at the Improvement Centre showing the results of the climate and screening strategies.

Explanation: Graphics are the ideal tool to see what is happening in the greenhouse. Here you can see how the screens opened and closed in the period around 1st harvest. The double XLS 10 was opening first followed by the XLS 10 REV H2no. During the day the XLS 10 REV H2no can be seen to close at 16:00 hrs on 11-04. This was triggered by low radiation (>150 W/m²) and/or the realised relative temperature difference between the calculated greenhouse temperature and outside temperature. In order for the pre-night temperature set point to be the XLS 10 REV H2no was forced to reopen and the XLS 10 REV was not allowed to close until 01:00 hrs.

Figure 2: Screen shot from the Priva computer at the Improvement Centre illustrating slab EC and WC at the time of first harvest.

Explanation: Screen shot from the Priva computer at the Improvement Centre showing how slab EC (red line) was stabilised between days of contrasting weather. On 11 April 2013, maximum radiation was 200 W/m² (orange line) on 12 March levels of 900 W/m² were achieved albeit for a short period of time. However, the substrate EC remained stable at 4.8-4.5mS.
Irrigation efficiency is the term used by GRODAN to define how the applied irrigation water is partitioned by a substrate between re-saturation, refreshment (EC control) and direct drainage. The most efficient substrates offer maximum refreshment with minimal drainage.

“So far, indications for crop quality are good (Picture 1), but if we see any infection the affected plant will be removed immediately in order to keep the infection pressure as low as possible, and if we need to rethink the approach to growing we shall do so,” says Piet Hein.

Aligning the irrigation strategy
The target for Piet Hein and Andrew was to lower slab EC from 9.4mS to around 5.0mS by the time the crop was harvesting. This has been achieved by slowly reducing the dripping EC from 4.0mS to 3.2mS as well as realising some drain from the Grotop Master slabs (Figure 2).

“The weather within this cropping period has been extremely variable so the start and stop times have had to be carefully managed,“ says Andrew. Outside temperatures have also been much lower compared to the yearly average (Table 1).

“So with the high number of screening hours we are always at risk for Botrytis infection. Therefore, the start time of irrigation has been adjusted.”

Irrigation can start only on light 230 J/cm² from sunrise. This generative strategy meant the researchers had to use large irrigation volumes, 4 to 6% of the total substrate volume per m² for which the Grotop Master slabs are ideally suited.

Keeping the slab EC stable between days of contrasting radiation even with low realised total drain volumes was aided by the high level of irrigation efficiency. The first harvest in week 15 yielded 0.70 kg/m².

Part 3 in the series will review crop steering from 1st harvest to longest day.

Moving forward into the next period of growth, the goal for the researchers is to optimise the balance in energy saving and humidity control and keep Botrytis infection to a minimum.

In respect to root zone management, the focus will be on how the XLS 20F Harmony REV screen will affect crop evapo-transpiration, watering strategy and ultimately yield.

Piet Hein concludes, “these articles are effectively live reports from an actual trial we are running: so far so good! It’s been an unusual year with very cold and dark weather: it’s been a real challenge.”

Further information
If you would like additional information in respect to sustainable greenhouse cultivation and specifically the trial work of the Improvement Centre and Grodan, direct your questions to info@greenQ.nl and info@grodan.com

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