GREENHOUSE TEMPERATURE DAY AND NIGHT

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A warm climate wears the plants out

Improving energy efficiency in a greenhouse is partly a matter of 'hardware' such as thermal screens, but also of smart control strategy. After all, every degree higher temperature or percent lower humidity costs energy.

Our aim is reducing the energy input while achieving the best possible production and quality. This is a fine art, which in recent years has brought us new innovative approaches such as 'the new way of growing', 'plant empowerment' and control of semi-closed greenhouses.

We continue the discussion about temperature control. In the April issue, we described the many influences of the average 24-hour temperature. In May, we presented the RTR graph as a tool to balance the average temperature with the average light level. This article is about the effects of day and night temperature.

Day temperature

Day temperature has a strong effect on cell division and stretching. Plant stems stretch most in the morning, and this is stimulated by high temperature. In an experiment, tomatoes were grown at 26°C day with 16°C night temperature, and another lot was grown at reversed temperature of 16°C day with 26°C night. Young tomato plants at 26/16 day/night grew much faster, became more than twice as tall and had 18% larger leaf area than those at 16/26 day/night temperature, due to increased cell division and stretching.

Photosynthesis is a key process that happens only during the day of course, and then there is respiration at day and night (see earlier articles). We are interested in nett photosynthesis (= sugar production minus breakdown), as that determines how much sugars are available for growth. Normally, higher day-time temperature has a weak positive effect on nett photosynthesis. Only if the CO_2 concentration is 800 ppm or more, a higher day temperature has a strong positive effect of nett photosynthesis. In that situation, the day temperature can best be set somewhat higher.

Day is part of 24 hours

Remember that the day temperature makes up a large chunk part of the 24-hour temperature, and as such it influences the development rate and other processes. In the experiment described above, the number of leaves was the same in both treatments, because both had the same 24-hour temperature and thus same development rate. Also, higher day and higher average temperature have a generative effect. Also higher temperature causes faster wear and tear of the leaves.

Day temperature control

On overcast days, heating is often needed to maintain the required temperature (also to reduce the humidity, but that is separate). In sunny weather, the art is to utilise the free energy from the sun. If it gets too warm, one option is to get rid of it by venting, but new innovative greenhouse control applies active cooling and ideally puts the heat in storage. Alternatively, a somewhat higher day temperature can be accepted and compensated by a lower night temperature, to maintain the required average temperature. The use of a screen, either transparent or non-transparent, will add a new dimension to temperature control. This will come later.

Night temperature

Respiration (burning of sugars) continues day and night. Lower temperature at night is good, as it reduces the respiration and thus leaves more sugars available for growth. In contrast, higher temperature in the pre-night is good for transport and processing of assimilates that were formed during the day. Especially after a sunny day, a lot of sugars are waiting for processing, and a (moderately)

A cooler climate keeps the plants shorter and fresher

Plants stretching occurs mostly in the morning, and is stimulated by higher temperature

Temperature strongly affects the shape of young seedlings

high temperature in the pre-night will speed that up. These two requirements seem conflicting, but it sorts itself out, because after a sunny day there is plenty of sugar, so losing a bit through respiration does not matter. The RTR graph (Radiation-Temperature Ratio, see previous article) shows that the average 24-hour temperature must be higher when the radiation sum is higher. So that naturally works out well.

Too high night temperature will burn assimilates unnecessarily. Too low night temperature creates starch accumulation, making the leaves less efficient the next day. With a suitable night temperature, the plants gain a lot of useable biomass after a sunny day and look fresh the next morning. The plant heads will indicate whether the generative/vegetative balance is adequate. Again, the use of a screen adds options to temperature control at night.

> **“Young tomato plants at 26/16 day/night grew much faster, became more than twice as tall and had 18% larger leaf area than those at 16/26 day/night temperature**

Dif

Dif is the difference between day and night temperature, e.g. a day of 22 °C with a night of 17 °C gives a dif of 5 °C. Not everybody uses dif, but it can be handy. Dif should vary between the seasons and even between days. Higher dif makes plants more generative. It also stimulates stretching. For some ornamental plants, dif is chosen negative, meaning that the day temperature is lower than the night temperature. This keeps those plants short and compact.

Young seedlings

Young seedlings must grow fast to occupy the ground and catch the available light. Important processes are developing new leaves, which depend on average temperature, and stretching, which depends on day temperature. In an experiment, tomato seedlings were grown at either 18 or 21°C average 24-hour temperature. Plants at 21°C clearly got much more leaves, due to a higher rate of leaf appearance, but the leaves stayed smaller. Net photosynthesis was similar, but the available sugars were shared over more leaves. The total leaf area in both temperature regimes was practically the same. Temperature strongly affects the shape of young seedlings.

Production phase

The experiment with 18 and 21°C average 24-hour temperature continued into the productive stage. At higher temperature, the tomato plants pumped more energy into their trusses and thus became more generative. This is because higher temperature has a positive effect on:

1. rate of appearance of new trusses,
2. sugar transport to fruit and
3. fruit growth and ripening. It took 56 days from fruit set to harvest at 18°C, and only 46 days at 21°C.

The higher temperature resulted in more fruit, but smaller fruit, as they shared the available sugars. Fruit weight can be increased by lowering the average temperature or apply fruit thinning.

In addition, higher average temperature wears the plants out faster. In the experiment, leaf picking was needed earlier at 21°C than at 18°C. Hence the leaf area got 25% smaller, so 25% less sugars were available for fruit growth. In this situation, the production was considerably lower at higher 24-hour temperature.