PLANT EMPOWERMENT (GPE), A NEW WAY OF GROWING

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It is time to introduce a new approach named 'Growing by Plant Empowerment' (GPE), which aims to grow in an energy efficient way, while achieving optimum production.

It started in the Netherlands around 2010, when the Dutch greenhouse industry was compelled to save more energy to comply with European climate change agreements. Energy efficiency had improved over several decades, but the energy consumption had not declined sufficiently. It was decided that drastic measures were needed, because *if you keep doing what you are doing, you keep getting the same result.*

Several research teams developed new ways of climate control, including semi-closed greenhouses, HNT ('the New Way of Growing'), GPE ('Growing by Plant Empowerment') and more, with overlaps between each approach. Growers who adopted the new concepts obtained markedly better energy efficiency, yield and fruit quality.

All these approaches are very comprehensive, for instance, GPE is described in a 300-page book.* In this article we can only scratch the surface. Three elements of GPE are briefly outlined: screens, plant temperature and humidity control.

'Growing by plant empowerment' (GPE) in a nutshell

GPE is based on maintaining the balances for water, energy and CO2 in the plant and in the greenhouse. Key elements of GPE are: (1) uniform climate, (2) smart humidity control, (3) using energy screen(s), (4) reduced heat emission, (5) air movement.

GPE requires some serious investment, namely in an energy screen, air fans and some extra sensors, including a leaf temperature sensor, thermo-camera, and an extra temperature and humidity sensor above the screen. This comes on top of the normal sensors for temperature, humidity and CO_2 near the plants, and the normal weather sensors. Another requirement is the grower's commitment and time for understanding the underlying physics and plant physiology.

Energy screen creates warmer plants

The most important tool in GPE would be the energy screen. A screen reduces the amount of energy needed for maintaining the required temperature, and more importantly, a screen keeps the plant heads warm. This is because a screen largely blocks the emission of long-wave radiation (heat radiation) from the plants to the cold greenhouse roof. It may seem a trivial detail, but it makes a significant difference.

On cold nights, in a greenhouse without a screen, plant heads get very cold, and therefore do not transpire any water. Hence the heads miss out on water supply from the roots which contains essential nutrients such as calcium. This in turn, causes calcium deficiency in growing points, leading to brown tips in young leaves and possibly blossom-end rot later in the fruit. Also, cold plant heads can get damp from condensation, and are thus prone to fungal diseases. In addition, non-transpiring plant heads get wet from guttation (caused by root pressure), leading to diseases. Proper use of an energy screen avoids all this, which is good for plant health and fruit quality, including reduced blossom-end rot.

Screening at daytime

The type of screen material used is very important. A (semi-)transparent screen can be used night and day. In GPE, a transparent screen is closed in the morning until the sun is powerful enough to maintain the required temperature. This is at about 250 Watt/m^2 solar radiation, measured outside with a pyranometer. This screen can be closed again some time before sunset.

In the traditional way, even transparent screens were opened before sunrise. This created a substantial spike in energy use early in the morning, because the heating system had to warm up the air in the growing space as well as in the cold top compartment above the screen. Also, it had to lift the temperature from the night level to the daytime level. Skipping this heating boost every morning can save an enormous amount of energy. The screen should not be closed the whole day though, as that makes plants soft and roots lazy.

Screen materials

A good screen lets a certain amount of moisture pass through to the compartment above the screen. This reduces the need for gapping and venting for humidity control, and thus saves energy. A good screen also has an 'anti-condense' attribute. This does not prevent condensation, but it makes that condensation form a thin film of water on the screen instead of large droplets that fall from the screen onto the plants.

One more thing: greenhouses located in cold winter climates overseas are fitted with two separate screens: one transparent and the other a heavy-duty energy saving screen. We won't elaborate on double screens here.

Humidity control as it was done

Energy consumption depends a lot on how the humidity is controlled. After all, reducing humidity requires a lot more energy than maintaining the temperature, especially in milder climates. Humidity control in GPE differs from the traditional way. Traditionally, humidity is reduced by concurrent heating and venting, and opening a small gap in a screen. Unfortunately, concurrent heating and venting increases the transpiration (which increases humidity!) and gapping creates cold spots. Some growers opt not to use the screen at all when the humidity gets too high, so they give up on potential energy saving on those nights.

Humidity control in GPE

GPE aims to use the screen as much as possible (in cold winter conditions). If a transparent screen is used, it can stay closed several hours of the day (see above). Non-transparent screens should be used at night only and opened shortly after sunrise (not before sunrise, for reasons described above).

In GPE, the humidity problem is avoided by using screen material that lets moisture through, and by using ventilation above the screen. Then the moisture travels to the upper compartment, where it condenses against the cold glass or goes out. (GPE uses ventilation on wind side and then leeside, which is different from traditional thinking.) In addition, the screen can be opened 10 or 20% (not just a crack) when it is not too cold outside. Of course, some energy is lost, but the advantage of the warmer plant heads outweighs the disadvantages.

More details and further actions such as the use of air movement and vertical fans will be discussed in a following article.

*Geelen, Peter A M, Voogt, Jan O, van Weel, Peter A, Plant Empowerment: The Basic Principles, 2018, www.plantempowerment.com

PE requires some extra measurements: at least an extra box for temperature and humidity above the screen, and a plant temperature sensor