

# THE ELEMENTS FOR SUCCESS

## CONTROL YOUR TEMPERATURE FOR YEAR-ROUND INDOOR GARDEN SUCCESS

Let's recap our six "essential elements" for a successful, productive hydroponic or indoor garden or greenhouse - Air (CO<sub>2</sub>), Humidity, Water (Quality), Nutrients (including minerals and rare earths), and Temperature.

Temperature is our last, but certainly not least important, of these six "essential elements". In nature, the seasonal variations of light intensity are responsible for the temperature changes from summer to winter in the various regions. Indoor gardens, if properly maintained, should offer a more temperate environment to boost year-round success.

### Plant Science

Each chemical, physiological, and biological plant process is influenced by temperature; and all plants have an ideal temperature zone for maximum vegetative growth and flowering with differing tolerances for hot and cold extremes. In general, the extreme temperature limits for plant growth are 39°F (4°C) and 122°F (50°C). At high temperatures, a plant's leaves begin to droop and stomata (tiny pores on the leaves and stems through which plants breathe) close to reduce excess fluid loss from transpiration. With these pores closed, a plant's ability to breathe in CO<sub>2</sub> is drastically reduced, retarding photosynthesis, energy production and growth. At temperatures above 104°F (40°C) photosynthesis stops altogether in most plants. Extremely high temperatures will destroy cell wall structures (protoplasm) leading to plant death. At very low temperatures, most plants cease all enzymatic and cellular functions, and growth subsides. Actively growing succulent tissues, such as flower buds, will be damaged more severely by cold than hardened or dormant plant tissues. Extremely low temperatures damage plant cell walls as well, allowing water to drain from the protoplasm during thaw, dehydrating the plant and eventually killing it.

During dark hours, when photosynthesis essentially ceases, respiration (the conversion of stored sugars to yield energy for cellular activities) becomes the dominant process. Like all other plant process, respiration is also temperature dependent, increasing 2-4 times every 18°F (10°C) and conversely decreasing when temperature declines.

### Insect Pests, Pathogens and Diseases

Insect pests prefer warmer temperatures and become much more active. Warm temperatures, coupled with moisture (humidity), also stimulate a number of plant pathogens. Fungi diseases such as grey mold and other *Botrytis* spp., common in tomatoes and peppers, favor warm, humid conditions. Some plant pathogens such as powdery mildew, prefer cooler conditions 60-70°F (15-21°C). There are probably a number of plant pathogens and insect pests present in your garden at any given time; however healthy plants readily out-grow or fight-off diseases and infestations. On the other hand, plants under temperature stress are vulnerable and more susceptible to infection and insect attack.

### Control Your Temperature

To eliminate temperature stress and damage, first determine the ideal temperature zone for the plants in your hydroponic or indoor garden. In the summer or warmer months, reduce heat from light systems by using air or water-cooled canopies, and if feasible locate ballasts away from growing areas or in another room. Choose high quality thermostats to help maintain the temperature zone in the environment around your plants. Many A/Cs and heaters offer on-board thermostats with high-low "comfort zone" settings. These type of thermostats cannot accurately sample the air temperature in your garden, when located on the appliance. For best results, use an independent, reliable temperature controller that integrates cooling and ventilation with CO<sub>2</sub> enrichment. Some temperature controllers also offer dual thermostats allowing you the flexibility to manipulate day (light) and night (dark) temperatures.

### CO<sub>2</sub> and Temperature

Plants in a CO<sub>2</sub> enriched environment will benefit from an accelerated metabolism and increased transpiration, enabling them to endure higher temperatures and harsher environments. However, you should not intentionally subject your plants to higher temperatures than they prefer. All plants have a favorite temperature at which their metabolic functions, including photosynthesis, are most efficient. Try to maintain that temperature in your garden during CO<sub>2</sub> enrichment. Coordinate your CO<sub>2</sub> monitoring and control systems with a temperature controller that overrides CO<sub>2</sub> production during cooling or air evacuation cycles, and dark periods.

### Track Your Temperature

Most flowering plants are adversely affected by an abrupt swing in temperature of more than 20°F. Plants are happiest if you keep your day and night temperatures within 10°F or so. A thermometer capable of recording the minimum and maximum temperatures in your garden is a useful tool for growing plants or crops that require more precision heating and cooling control.

### The Elements for Success

If you replicate the daily and seasonal conditions - the ideal temperature, humidity and light that your plants favor in nature, and offer the optimum balance of high quality water, nutrients and CO<sub>2</sub>, your hydroponic or indoor garden will flourish.

For more information on how temperature influences plant growth and development, check out these helpful resources:

- Determine Effect of Temperature on Plant Growth. <http://www.cms.ag.ohio-state.edu/AgSciLPS/HTML/506.html>
- Green Air Products. [www.greenair.com](http://www.greenair.com)
- Hartmann, Hudson, A. Kofranek, V. Rubatzky, W. Flocker. *Plant Science - Growth, Development & Utilization of Cultivated Plants*. 2nd edition. NJ: Prentice Hall, 1988.
- Kenaga, Clare B. *Principles of Phytopathology*. 2nd ed. IL: Waveland Press, 1986.
- Plants and Light-Energy Input into Ecosystems. <http://www.tomatosphere.org/EngManual/activity9a.html>
- Temperature Relations in Plants and Animals. <http://www.colorado.edu/epob/epob3020bowman/04.html>

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