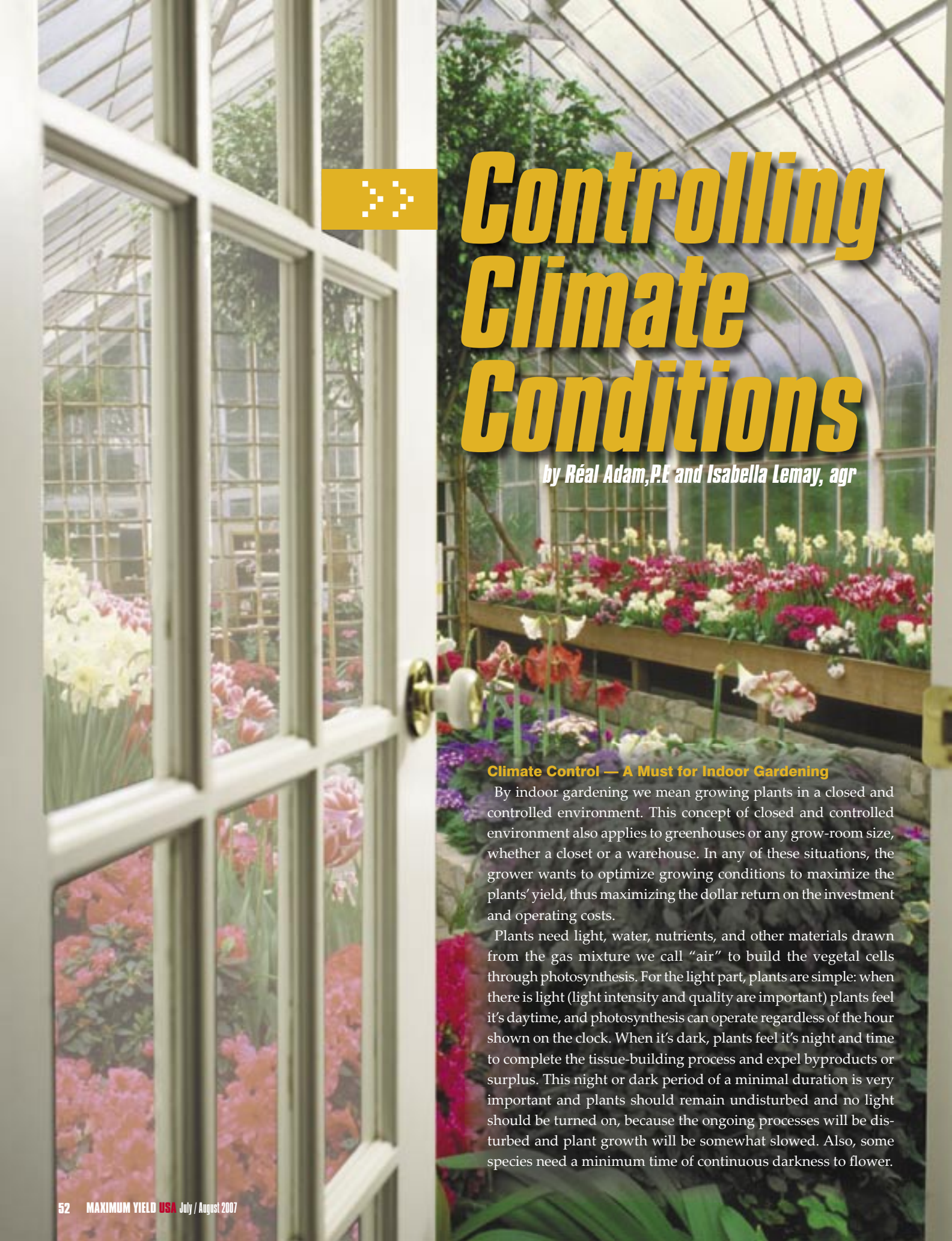


Controlling Climate Conditions

by Réal Adam,P.E and Isabella Lemay, agr

Climate Control — A Must for Indoor Gardening

By indoor gardening we mean growing plants in a closed and controlled environment. This concept of closed and controlled environment also applies to greenhouses or any grow-room size, whether a closet or a warehouse. In any of these situations, the grower wants to optimize growing conditions to maximize the plants' yield, thus maximizing the dollar return on the investment and operating costs.

Plants need light, water, nutrients, and other materials drawn from the gas mixture we call "air" to build the vegetal cells through photosynthesis. For the light part, plants are simple: when there is light (light intensity and quality are important) plants feel it's daytime, and photosynthesis can operate regardless of the hour shown on the clock. When it's dark, plants feel it's night and time to complete the tissue-building process and expel byproducts or surplus. This night or dark period of a minimal duration is very important and plants should remain undisturbed and no light should be turned on, because the ongoing processes will be disturbed and plant growth will be somewhat slowed. Also, some species need a minimum time of continuous darkness to flower.

Keep the Stomas Open

Plants are also living organisms with failsafe mechanisms encoded in their DNA to survive the ever-changing climate conditions in a natural outdoor environment. They act like each species has its own personality. They are sort of moody when it comes to climate conditions. The plant breathes through stomas mainly located at the lower surface of leaves. These stomas act like two-way valves to let air in and expel unwanted gases and water vapor from transpiration. When one climate condition is threatening to damage part of or the whole plant the stomas close. Even if light, water, and nutrients are available in abundant quantity and quality, when the stomas shut the photosynthesis stops, hence the growth and the blooming. The plant maturation stops until the climate variable that caused the stomas to close gets back in the appropriate range for the plant to operate photosynthesis and growth.

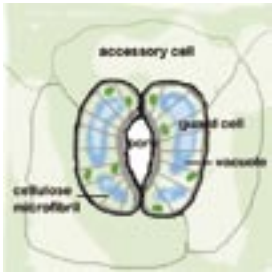
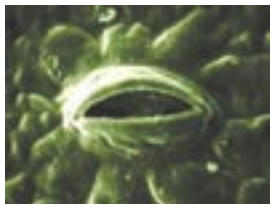


Diagram of a plant stoma


Photograph of an open stoma with a magnification of 2900X.

So, climate conditions are important to plants and climate control in a closed environment is a must. If temperatures are too hot or too cold, or if the relative humidity is too low, growth stops. When relative humidity is too high transpiration is slowed, so water and nutrient absorption slows accordingly. Relative humidity going too high is also a concern because of the risk of pests like fungi and bacteria, which will attack plants if allowed to develop.


The number of stomas varies with the plant species from 30,000 to 325,000 per square inch.

How Important is CO_2?

Basically, when stomas close the carbon intake from breathing the carbon dioxide shuts down and the plant is deprived from this important source of building material for the cells. Plants are made up of organic chains composed of oxygen, hydrogen, nitro gen, and carbon. If any of these atoms are unavailable in the right

An orchids enthusiast indoor grow room

When plants appeared on Earth and evolved into the various species, carbon dioxide levels were much higher than they are now

proportion, tissue building and growth are slowed to use just what's available. Since hydrogen, oxygen, and nitrogen may come from water pumped through the roots, carbon dioxide from the air becomes central to further fast growth. Proper temperature and relative humidity will keep the stomas open for carbon dioxide intake in the presence of light. Thus, it is important to maintain minimum ventilation with fresh air to supply the plants in carbon dioxide as it is drawn and used. Climate control is obviously important to maintaining proper conditions for growing plants at a sustained high rate in a closed room.

When plants appeared on Earth and evolved into the various species, carbon dioxide levels were much higher than they are now. These concentrations of CO_2 were certainly above the 1000 parts per million (ppm) compared to the 400 ppm average that can be measured outdoors in a highly urbanized area. So many species of plants will react, grow, and mature faster at higher levels of carbon dioxide. That's why carbon dioxide enrichment is extensively used by growers, providing more building material for the plant to transform into biomass and to get faster and higher yield results.

"For Relative humidity, a range as low as five percent might be required."

Controlling Climate is Demanding

So, plants are somewhat bad-tempered. Each species requires a specific set of climate conditions, which are different at day or night. Yet if the grower wants to get the best possible results, he has to make sure the conditions are maintained within a range close to the actual required settings. A grower can choose to manage the conditions himself by watching meters, pushing buttons, and turning knobs to raise temperature and lower relative humidity, as for day and night. He may also choose to use simple controls: a lighting timer is fine; a cycle timer for repetitive operations like irrigation is also fine. When it comes to temperature and humidity controls, a simple thermostat and hygrostat will not fit unless they are expensive controlling devices that can maintain a condition in a very close range and are set to operate at different day and night settings. To control temperature, a range as tight as ± 2 degrees Fahrenheit (± 1 Celsius) around the setting is needed. For relative humidity, a range as low as five percent might be required.

Tomato plants thriving in an indoor garden

Climate controllers with digital sensors and day or night recognition offer these tight ranges and high accuracy. Again, one may choose to enrich the atmosphere of the grow room in carbon dioxide under the control of a timing device. What is the actual CO_2 concentration in the room? Is it in the right range for the plant to maximize its use of CO_2 and grow faster? A CO_2 controller is easy to set, offers the grower a displayed value of the actual concentration, and sometimes records hourly average readings to monitor the good working condition of the enrichment system. Climate controllers certainly cost more, but will certainly bring results according to the species and the grower's settings.

Single Variable Controller or Integrated?

Temperature modifies relative humidity. Carbon dioxide enrichment by burning propane or natural gas produces heat and water vapors, increasing temperature and relative humidity accordingly. Then growers want to lower the temperature, often using fans to bring cool air in the growing volume and evacuate outside warm air, thus expelling the CO_2-enriched air at a cost. Other growers just want to regularly draw fresh air to use ambient CO_2. Many of them use air conditioning units to lower temperature and relative humidity by condensing water vapors, while some would rather use dehumidifiers. No grow rooms are the same; no two growers manage their grow room and crops the same way. Maintaining a growing environment climate at optimal cropping conditions can be pretty tricky. Again, ensuring a 24/7 full control is time consuming and requires a constant human presence. The grower al-