**Bruce Briggs:** How do you feel as a displayer of carefully walking the line between selling a product and providing needed information to inform growers?

**Richard Vollebregt:** The last thing we (sales people) need is another trade show. In order for us to sell anything we have to educate because we are trying to tell people that there are different ways of doing things. At trade shows you never get a chance to sit down and talk in detail like we were able to do here. With the understanding that this is not designed to be a commercial forum, I'm more relaxed and I think the people here are more relaxed because the focus is education. My perception is that it would be taboo for it to be anything else.

# Motivating Plant Growth With Your Heating System

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## INTRODUCTION

Plants exist in several temperature microclimates simultaneously. A microclimate is defined for this paper's purpose as a small environment that is confined by the structure of the greenhouse, the structure of the plant, and the root zone.

The primary aim of this paper is to heighten the reader's awareness of the existence of these microclimates and to outline the tools that are available today to control the temperature in each. It is essential to understand that providing the optimum temperatures to all the plant's microclimates is essential to achieving maximum quality and production.

To create a reference point for this, I suggest that you try to understand the way a specific plant evolved in nature. Very often this simple approach will yield a very good recipe for creative use of the tools that are available for this purpose. To illustrate the impact microclimate temperature control can have, I asked several growers for feedback as to what effect this approach has had on their production.

**Example 1**: A well known orchid grower found that, "By controlling our soil temperature at 70F with an air temperature of 63F, we were able to eradicate a major root-fungus problem, called *Pellicularia filamentosa*, that had been rampant when we only controlled air temperatures. . . "

**Example 2**: A cut rose grower found that, "By heating our plants from below, and letting the warmth move up through the plant, we've seen more bottom breaks, bigger heads, and much less chemical usage. . . "

**Example 3:** A potted foliage plant grower discovered that, "By elevating our soil temperatures above 68F we have seen much higher production and an elimination of iron chlorosis..."

All three of the growers were exercising a very simple cultural practice—they were creating temperature microclimates that mimicked the environments that their particular crops had adapted to naturally. Simply taking a step back and objectively asking yourself "If I could think like a plant, what would I want for temperature control?", may be the most important practice you could make.

## TEMPERATURE CONTROL "TOOLS"

There are basically three commercially viable ways to deliver heating energy to your crops: (1) hot air convective systems, (2) infra-red radiation systems, (3) hot water distribution systems.

Interestingly, hot water as a medium can be applied to your production facility in many different ways these include:

- Under bench or perimeter pipes
- Under bench or perimeter finned pipes
- On-bench systems
- Under floor systems
- On floor systems
- And, of course, as hot air!

Steam systems are no longer an affordable medium of heat delivery, because of high maintenance and high initial cost. Here is a reference chart that outlines the advantages and disadvantages of each system.

| Advantages | Disadvantages |
|---|---|
| **Hot air** | |
| Inexpensive | Expensive to operate |
| Easy to install | High maintenance |
| Helps humidity control | Uneven distribution |
| **Infra-red** | |
| Energy saving | High initial cost |
| Dry foliage | Descending soil temps |
| | Even-heating can be "black magic" |
| | Hard to control |
| | Casts shadows |
| | Won't adapt to all potential areas |
| **Hot Water** | |
| Placement of BTUs very flexible | Initial cost |
| Combination conduction, radiation, and convection heating | Installation can be time consuming |
| Combustion takes place away from greenhouse in boiler room | |
| Not tied to any particular fuel | |
| Many zones in same house | |

The best application of each system described above is shown below:

- Hot air—Bedding plants, freeze protection, supplemental heat
- Infra-red—cut flowers, vegetables, blooming house plants
- Hot water—propagation, bedding, holiday crops, vegetables, germination.

Keep in mind that each system has its own inherent "skills" and that your "ultimate" system may actually be a combination of systems. This may be the answer to creating ideal conditions for your specific situation. As an example, very

often growers will choose a hot water system for media and plant warming from below, and install a forced air system overhead for overall air temperature, snow melting, and humidity control.

## TECHNICAL ADVANCEMENTS

Technology is advancing in all heating product segments, at an increasingly rapid pace. These enhancements are being driven by a demand for higher efficiency equipment, pressures being brought to bear by environmental protection agencies for cleaner burning equipment, and the customer's desire for less frequent maintenance intervals. The enhancements include:

| | |
|---|---|
| **Hot-air systems** | Separated combustion<br>Higher efficiency<br>Tubular heat exchangers |
| **Infra-red systems** | Temperature uniformity<br>Reliability<br>Corrosion problems reduced |
| **Hot-water systems** | Low-mass boilers with pressurize combustion<br>Sealed (separated) combustion<br>Better distribution (heat delivery) materials. |

## COST ANALYSIS

The three systems discussed in this paper have varying initial costs which vary according to the complexity and size of the installation. The following serves as a cost reference for systems in a 10,000 to 40,000 $ft^2$ greenhouse application.

| | |
|---|---|
| **Hot-air systems** | 30¢ to 50¢ per $ft^2$ |
| **Infra-red systems** | \$1.50 to \$2.00 per $ft^2$ |
| **Hot-water systems** | \$1.00 to \$2.50 per $ft^2$ |

## ANNUAL OPERATING COSTS

Annual operation costs for each system vary as well. The following chart provides operating costs for systems installed in a typical northern greenhouse:

| | |
|---|---|
| **Hot-air systems** | \$1.00 |
| **Infra-red systems** | 60¢ |
| **Hot-water systems** | 60¢ |

To summarize, the tools you need are available and affordable. You can mimic almost any environment to optimize production, if you take time to research your plants actual requirements and apply the tools creatively.