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How Low Can You Go?

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This is one of many seminar presentations originally planned for GrowerExpo 2002 that we'll be bringing to you in the pages of*GrowerTalks*in the coming months.

The increase in energy prices last year prompted many growers to lower their greenhouse temperatures in an attempt to save money. Fortunately, natural gas and fuel oil prices have returned to more normal levels this winter. However, energy prices are very volatile and we'll likely encounter high energy costs in the future. That's why it's important to understand how temperature influences crop timing and plant quality so that you can optimize your production schedules and still produce high-quality plants.

Here are answers to five commonly-asked questions about the temperature/cost relationship:

Can I lower my temperature without delaying my crops?

No. "Temperature controls crop timing"--such a simple, yet important statement to understand. Within the typical temperature range of most greenhouses during the winter, plants develop leaves and flowers progressively faster and faster as temperature increases. Thus, turning down the thermostat during the day or night will delay your crop. In other words, if you grow plants at cooler-than-normal temperatures, production time will be longer. As the expression goes, "there's no such thing as a free lunch."

How does temperature influence crop timing?

As temperature decreases, there is some temperature at which a plant stops to grow and develop. This temperature is called the *base temperature*, and varies widely by crop. For example, the base temperature for petunia Express Blush Pink is about 39F, which means that at or below this temperature, petunias stop growing. For vinca Grape Cooler, the base temperature is much higher, around 50F.

As the temperature increases above the base temperature, plants grow faster and faster. The chart illustrates the time it takes for petunia and vinca plants to flower at various temperatures. As the temperature increases above the base temperature, a small increase in temperature can make a big difference in the time to flower. As we get to warmer temperatures, the same increase in temperature has a smaller effect on accelerating flowering.

As temperature increases, there is some temperature at which the rate of development is at its maximum. This is referred to as the *optimum temperature*, and also varies widely among plant species. At temperatures above the optimum, plants begin to experience heat stress, and the rate of plant development decreases.

Crop development is driven by the temperature of a plant. In many situations, plant temperature is somewhat similar to the air temperature. However, other environmental factors influence plant temperature, such as light intensity,

humidity and wind speed. Keep in mind that the temperature of the plant is what drives its rate of development, not the greenhouse air temperature.

How much longer would it take to grow a crop if I lower my greenhouse temperature?

As we see in the example with petunia and vinca, lowering the temperature by 5F has a somewhat small effect at warm temperatures, but a larger effect at cooler temperatures. When growing plants cooler they clearly take longer to develop, but the magnitude of the delay varies by species. For example, lowering the temperature from 65F to 60F would cause petunias to take about 13 days longer to flower, but would cause vinca to take about 30 days longer!

The reason for the difference in how temperature influences crop timing is related to the base temperature of a species. Plants with relatively low base temperatures (petunia and pansy, for example) will continue to grow at cool temperatures. However, plants with high base temperatures (vinca and impatiens) grow very slowly at cool temperatures. Therefore, how much extra time it takes to grow a crop at cooler temperatures depends on the crop.

How does my greenhouse temperature influence heating costs for each crop that I grow?

There's a trade-off between lowering the heating setpoint for crops during the winter and spring, and the finish time of a crop. Obviously, less heating translates into lower fuel consumption per month, meaning that your monthly energy bills are lower. However, a temperature reduction to save money also increases crop timing, meaning plants are in your greenhouse longer.

A longer production time has several negative consequences. First, overhead expenses (cost per square foot per week) are greater for that crop. Second, because the crop takes longer to finish, you'll turn fewer crops per year.

For example, if you grew vinca from plugs to flower from January 1 through May 20, you could produce about four crops growing them at 75F. During that same period you could only produce three crops if you had lowered your greenhouse temperature to 69F. Assuming you can sell all the plants you grow, fewer turns translates into less income.

Third, a longer crop time means that you'll have to heat the crop longer (albeit at a lower temperature)--but you could end up spending more on energy on that crop than if you didn't lower the temperature and had produced the crop more quickly!

Using weather data for East Lansing, Michigan in 2000, and making some assumptions based on greenhouse structures, we estimated fuel costs for petunia and vinca crops being grown at different temperatures at different times of the year.

As the chart indicates, petunia or vinca grown at warmer temperatures flowered faster and energy costs per crop were lower compared to if plants were grown at cooler temperatures.

For example, to finish a petunia crop on March 1, it would have to be planted around December 24 (68 days before finish date) if grown at 60F, vs. January 6 (55 days before finish date) if grown at 65F. The estimated heating cost per crop would be $0.24 per square foot at 60F and $0.21 per square foot at 65F. That means in this instance, a warmer growing temperature is a wiser economic choice if the greenhouse can be shut down from December 24 to January 6, or if another crop can occupy the space during that time.

What effect does temperature have on plant quality?

For many crops, plant quality *increases* as growing temperature *decreases.* If plants are grown at similar light intensities but at different temperatures, those grown at cooler temperatures will generally have thicker stems, greater branching and more, larger, more colorful flowers. Exceptions to this are plants that grow best in warm

conditions. Therefore, one of the benefits of growing at cool temperatures is that overall plant quality can be improved. However, remember that some plants, especially warm-season plants, can experience chilling injury at cool temperatures.

Putting the pieces together

To summarize, the advantages of growing warm include shorter crop timing, which offers the potential for more crop turns per year; avoid chilling injury problems; and, in many instances, lower energy consumption per crop grown.

The main advantage of growing cool is improved plant quality, such as more flowers and thicker stems. Of course, there are other considerations about growing cool that we haven't discussed, such as the possibility of increased disease pressure.

Deciding on whether to grow cool or warm is situational, and something every grower should evaluate for himself based on the pros and cons. Turning down the thermostat can translate into lower monthly energy bills, but this could backfire--the crops take longer to flower, and you could end up spending more money on heating each crop since it's the greenhouse longer. However, it might be more economical to grow cool if your greenhouse can't otherwise be shut down or if another crop wouldn't occupy that space.

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