Manage temp for the best spring crops

Greenhouse temperatures influence crop timing and quality, so be careful.

By Erik S. Runkle

Growers are increasingly manipulating the greenhouse environment to shorten crop production time and save on fuel costs. Successful strategies that can shorten spring crop production include providing long days to long-day plants, providing supplemental lighting to young plants and growing plants warmer to accelerate development.

Given the high cost of heating, many growers are lowering the greenhouse temperature set points. While there are some advantages to lowering the thermostat, some negative consequences can arise.

DAILY TEMPERATURES

Temperature is the primary factor that controls the rate of plant development. As the average daily temperature decreases, at some point a plant stops developing. The low temperature at which a plant stops developing is called the base temperature, and it varies from crop to crop.

Plants develop in response to the average daily temperature. A crop grown at a constant 65°F will develop in the same amount of time as the same crop grown at a day/night temperature of 70°F/60°F if the day and night are 12 hours each. Thus, cooler nights without warmer days will increase the time it takes to transplant or finish a crop. If the night temperature settings are longer than 12 hours, you need to offset the shorter day temperature by more so that the 24-hour average temperature stays the same.

MANAGE CROPS INDIVIDUALLY

The effect of temperature on plant development depends on the species. Researchers at Michigan State University have identified cold-tolerant crops (which continue to develop at relatively low temperatures, including ageratum, alyssum, nemesia, pansy and petunia) and cold-sensitive crops (have a higher base temperature and require a higher growing temperature for rapid development, including *Salvia farinacea*, celosia, hibiscus, vinca and

Predicted fuel cost to heat 3 crops

CROP	APRIL 1 FINISH				MAY 15 FINISH			
	57°F	63°F	68°F	73°F	57°F	63°F	68°F	73°F
	GRAND RAPIDS, MICH.							
Celosia	$6,035	$3,486	$3,158	$3,134	$3,266	$1,667	$1,654	$1,742
Impatiens	$2,411	$2,156	$2,050	$2,144	$981	$1,007	$1,008	$1,078
Salvia	$2,930	$2,592	$2,446	$2,381	$1,236	$1,241	$1,243	$1,262
	COLUMBUS, OHIO							
Celosia	$4,899	$2,797	$2,701	$2,721	$2,230	$924	$964	$1140
Impatiens	$1,919	$1,761	$1,704	$1,710	$454	$520	$624	$781
Salvia	$2,355	$2,171	$2,061	$2,030	$590	$647	$758	$867
	CHARLOTTE, N.C.							
Celosia	$2,774	$1,495	$1,615	$2,035	$1,105	$676	$745	$971
Impatiens	$786	$1,000	$1,078	$1,216	$256	$398	$398	$494
Salvia	$1,068	$1,168	$1,293	$1,373	$366	$453	$583	$622

Each crop occupied 10,000 square feet of greenhouse space from date of transplant until finish dates of April 1 or May 15 for three locations at four average daily temperatures with a 16-hour photoperiod and daily light integral of 10 moles per square meter per day.

Energy consumption predictions are based on outputs from Virtual Grower developed by USDA Agricultural Research Service in Toledo, Ohio.

Greenhouse characteristics: five spans each 100 by 20 feet, north-south orientation of average construction, double-poly glazing with arched roof, 3-foot insulated concrete knee wall, 9-foot gutter, 12-foot peak height, 70-percent efficient heater, no curtain system and natural gas at $1.25 per therm.

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PROGRAM ESTIMATES ENERGY USE
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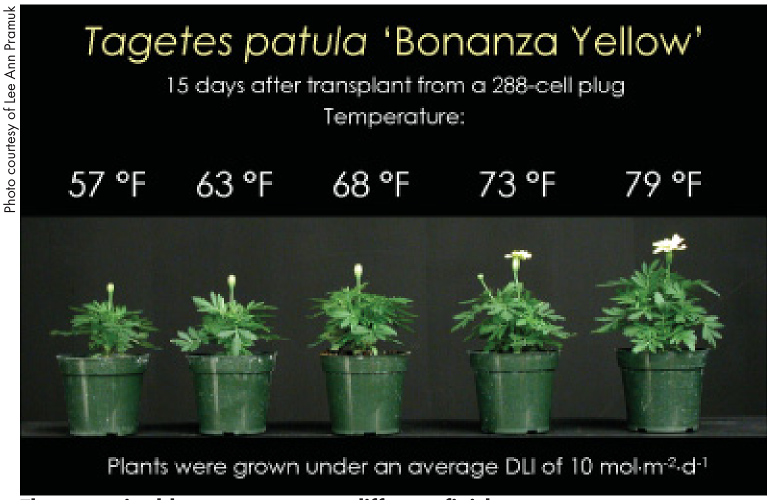
Approximate date of transplant for flowering on April 1 or May 15

CROP	APRIL 1 FINISH				MAY 15 FINISH			
	57°F	63°F	68°F	73°F	57°F	63°F	68°F	73°F
Celosia	Jan. 10	Feb. 15	Feb. 23	Feb. 27	Feb. 23	March 31	April 8	April 12
Impatiens	Feb. 20	March 1	March 6	March 9	April 5	April 14	April 19	Apr 22
Salvia	Feb. 13	Feb. 24	March 2	March 6	March 29	April 9	April 15	April 19

Plants were produced from 288-cell plugs at four average daily temperatures with a 16-hour photoperiod and average daily light integral of 10 moles per square meter per day.

Although energy has become a major production expense, scheduling decisions should not be based on energy inputs alone.

Photo courtesy of Lee Ann Pramuk



These marigolds were grown at different finish temperatures.

most tropicals). Ideally, cold-tolerant crops should be grown in separate greenhouses at lower temperatures than cold-sensitive crops.

As the growing temperature approaches a plant's base temperature, the crop is increasingly delayed. For example, celosia production takes eight days longer when grown at 63°F compared to 68°F. It takes celosia about 36 days longer to flower when grown at 57°F compared to 63°F. For crops with a higher base temperature, such as impatiens and red salvia (*Salvia splendens*), there is less of a flowering delay at these same temperature changes.

If plants are to be sold in flower on April 1, then celosia grown at 57°F would have to be transplanted on Jan. 10. However, if celosia was grown at 73°F, then it could be transplanted on Feb. 27.

EARLY FINISH VS. LATE FINISH

The growing temperature in which the least amount of heating energy is consumed per crop depends on species, location and market date, according to research at Michigan State.

For an early finish date (April 1), the least amount of energy was consumed when plants were grown warm in relatively cold climates (Grand Rapids, Mich., and Columbus, Ohio). Crops grown cool had to be transplanted earlier to be marketed on the same date, which required heating during the colder part of the year. Heating costs for cold-sensitive crops were much higher when the crops were grown cool for a long time.

In Charlotte, N.C., heating costs were lowest when crops were grown cool and planted earlier.

Approximate days from transplant until first flowering

PLANT	AVERAGE DAILY TEMPERATURE			
	57°F	63°F	68°F	73°F
Celosia	81	45	37	33
Impatiens	40	31	26	23
Salvia	47	36	30	26

Plants were produced from 288-cell plugs at four average daily temperatures with a 16-hour photoperiod and daily light integral of 10 moles per square meter per day.

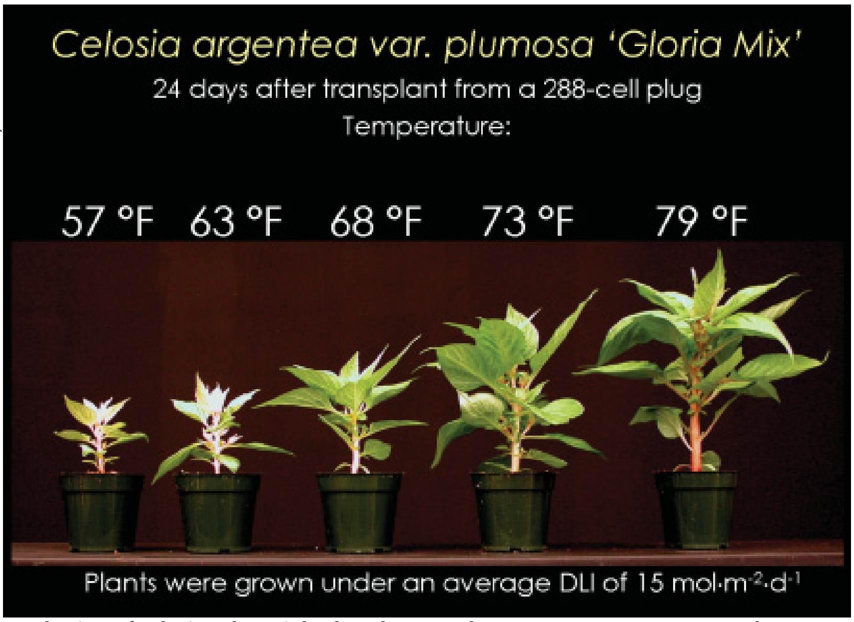
Program estimates energy use

Virtual Grower is a free computer program that estimates the amount of energy consumed to heat a greenhouse, developed by the Greenhouse Production Research Group at the USDA Agricultural Research Service in Toledo, Ohio.

It helps growers understand how growing temperature, time of year and greenhouse characteristics influence energy costs for heating. Using this program with data on plant responses to temperature, heating costs can be estimated for different growing situations.

◆ **For more:** *www.ars.usda.gov/services/software/download.htm?softwareid=108.*

Photo courtesy of Lee Ann Pramuk

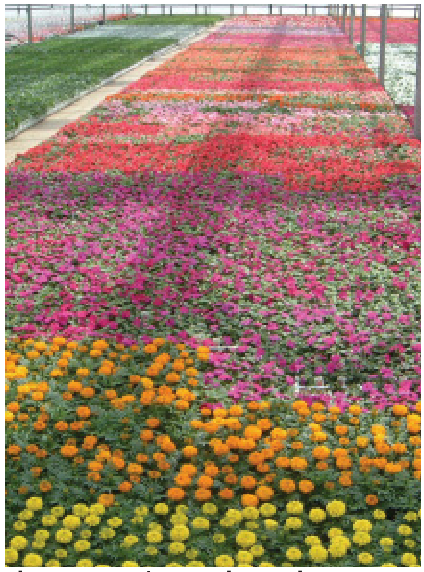


Production of celosia takes eight days longer when grown at 63°F compared to 68°F. It takes celosia 36 days longer to flower when grown at 57°F compared to 63°F. Plants grown at 63°F were chlorotic.

This is because the amount of energy used to maintain a greenhouse at 57°F or 63°F during late winter and early spring is relatively low. Less than half of the energy consumed in Grand Rapids was consumed in Charlotte for the three greenhouse crops finished on April 1.

There is one major benefit to growing crops relatively cool in early spring, when light is limiting in northern latitudes. Crops grown cool take longer to flower, so they have a longer time to accumulate light. Because of this, many crops are higher quality (more branching, thicker stems and more flowers) when grown at moderately low temperatures.

The cost to heat a crop for sales on May 15 is obviously less than the cost for an earlier finish date because the



Plants grown in a cool greenhouse take longer to dry out, so they stay wet longer.

weather is warmer outdoors. In all three locations, the estimated heating costs were lowest when celosia was grown at a moderate temperature (63°F or 68°F) and impatiens and red salvia were grown cool (57°F). Less energy was consumed by growing crops cooler and longer than growing the crops warmer and shorter late in spring.

PUTTING THE PIECES TOGETHER

Heating cost is only one of the factors that should be considered when scheduling crops. For example, a grower trying to squeeze in three crop turns during spring may have no choice but to grow at higher temperatures so that crops finish quickly.

Plants grown in a cool greenhouse take longer to dry out, so they stay wet longer. Also, since cool air holds less moisture than warm air, the relative humidity can be higher in a cool greenhouse. Pathogens can be more problematic when crops are kept moist and the humidity is high.

Other factors that can influence crop timing include photoperiod, daily light integral, starting plug size, finish plant size, application of plant growth regulators and pinching plants. Although energy is a major production expense, scheduling decisions should not be based on energy inputs alone.

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