Energy-Efficient Annuals

Scheduling Bedding Plants

In part two of a 12-part series, researchers from Michigan State University and USDA present research-based information for scheduling annuals in a more energy-efficient and predictive manner.

by ***ERIK RUNKLE, JONATHAN FRANTZ*** and ***MATTHEW BLANCHARD***

DESIRABLE scheduling of garden plants includes producing a marketable crop for a specific date with the least amount of inputs as possible. A large contribution to input costs for greenhouse production are overhead expenses (often calculated on a cents-per-square-foot basis). During winter and early spring production, heating can be a large component of overhead costs, especially for growers in the North. As a result, some growers have lowered their growing temperature in an attempt to save on fuel costs.

When greenhouse temperature is lowered, plants develop more slowly, so production time increases. The effect of temperature on crop timing depends on several factors, most notably on the crop grown. In this series of articles, we are presenting research-based information on the effect of temperature on crop timing of a variety of popular bedding plants. We then can estimate the cost to heat a greenhouse given the temperature, cropping time, and greenhouse characteristics.

Signing On To Software

Estimating heating costs for different greenhouse production scenarios was nearly impossible several years ago. That has changed. Virtual Grower is a free, user-friendly computer program that enables anyone to virtually create their greenhouse and then predict the effect of changing different parameters on heating costs. Using temperature and crop timing data, we can use Virtual Grower to estimate heating costs throughout the bedding plant season and beyond. This ultimately allows us to project the most energy-efficient growing temperature.

Some of the parameters that one can enter in Virtual Grower are location, scheduling time, greenhouse characteristics (glazing, side wall composition, size, roof type, etc.), fuel type and cost, "leakiness" of a greenhouse and utilization of an energy curtain (**Figure 1**). To obtain a free copy of Virtual Grower, and for more information on the program, visit **www.VirtualGrower.net**.

Let's illustrate the utility of Virtual Grower and our crop timing information with petunia 'Easy Wave Coral Reef.' We grew 288-cell plugs under a 16-hour long day until they were ready for transplant. Plugs were transplanted into 4-inch pots and grown at a range of constant day/night temperatures, all with a 16-hour photoperiod using high-pressure sodium lighting. We also grew plants at different daily light integrals, but we'll discuss that in future articles. As expected, petunia developed progressively faster as temperature increased. Time from transplant of a completely vegetative 288-cell plug to first flowering took 62 days at 58°F (14°C), 42 days at 63°F (17°C), 30 days at 68°F (20°C), and 26 days at 73°F (23°C).

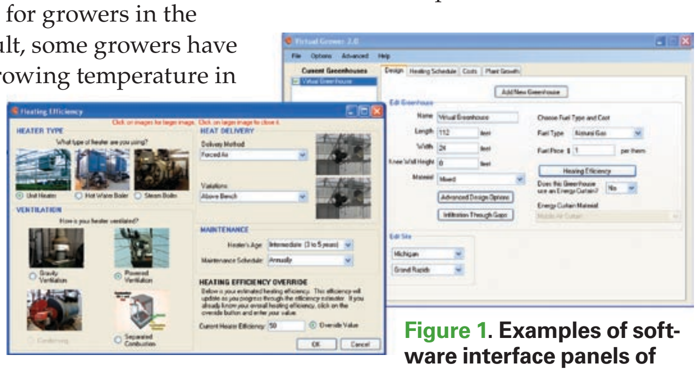

Figure 1. Examples of software interface panels of Virtual Grower. This program can be downloaded free at VirtualGrower.net and can be used to estimate greenhouse energy costs throughout the United States.

Date of transplant of 288-cell plugs for desired market dates							
April 1				May 15			
58°F	63°F	68°F	73°F	58°F	63°F	68°F	73°F
Jan. 29	Feb. 18	Mar. 2	Mar. 6	Mar 14	Apr. 3	Apr. 15	Apr. 19

Table 1. Date of transplant of 288-cell plug trays of petunia 'Easy Wave Coral Reef' to achieve first flowering when grown at different temperatures for two market dates. Plugs were grown under a 16-hour long day and were completely vegetative at transplant. A 16-hour long day and an average daily light integral of 10 mol·m^{-2}·d^{-1} were provided during the finish stage.

Using this information, we can then identify the date that plugs need to be transplanted for two different finish dates: April 1 and May 15. For example, if we want first flowering of this petunia on April 1 and we want to grow at an average daily temperature of 63°F, then plugs should be transplanted on Feb. 18 (**Table 1**). Or, we can grow at 68°F and delay transplanting until March 2.

Location	Estimated heating cost (U.S. dollars per square foot per crop)							
	April 1				May 15			
	58°F	63°F	68°F	73°F	58°F	63°F	68°F	73°F
San Francisco, Calif.	0.13	0.14	0.15	0.16	0.10	0.11	0.11	0.13
Tallahassee, Fla.	0.14	0.11	0.10	0.11	0.04	0.03	0.02	0.03
Grand Rapids, Mich.	0.56	0.40	0.31	0.30	0.26	0.18	0.15	0.15
New York, N.Y.	0.38	0.29	0.24	0.24	0.15	0.11	0.10	0.11
Charlotte, N.C.	0.24	0.15	0.15	0.16	0.08	0.07	0.07	0.07
Cleveland, Ohio	0.49	0.36	0.28	0.29	0.22	0.16	0.13	0.15
Fort Worth, Texas	0.15	0.12	0.10	0.11	0.03	0.02	0.03	0.04

Table 2. Estimated heating costs to produce flowering petunia 'Easy Wave Coral Reef' (from a 288-cell plug; see Table 1) at different temperatures and locations for first flowering on April 1 or May 15. Cities were chosen from each of the seven leading garden plant-producing states. Calculations performed with Virtual Grower 2.0 software with constant temperatures. Greenhouse characteristics include: eight spans each 112 by 24 feet, arched 12-foot roof, 9-foot gutter, polyethylene double-layer roof, polycarbonate bi-wall ends and sides, forced air unit heaters burning natural gas at $1 per therm ($10.24 MCF), 50 percent heater efficiency, no energy curtain and an hourly air infiltration rate of 1.0.

Estimating Heating Costs

Finally, we can use Virtual Grower to estimate the energy cost for heating a greenhouse given the different crop schedules. We calculated this cost for a variety of locations throughout the United States (**Table 2**). Data is expressed as the heating cost per square foot of production area per crop (not per week). For example, the heating cost to produce a petunia crop in Grand Rapids, Mich., for a desired finish date of April 1 was 56 cents per square foot when transplanted on Jan. 29 and grown at 58°F, and 31 cents when transplanted on March 2 and grown at 68°F.

Using more locations, we quantified the heating cost to produce this petunia at different locations for an April 1 finish date. Figure 2 provides the change in heating cost (per square foot per crop) to produce petunia at 58°F compared to 68°F. Except for the two locations in California, less energy was consumed by growing the crop warm (68°F) compared to growing it 10°F cooler because of the substantial increase in production time. Thus, an earlier transplant date is required for a cooler production temperature, and

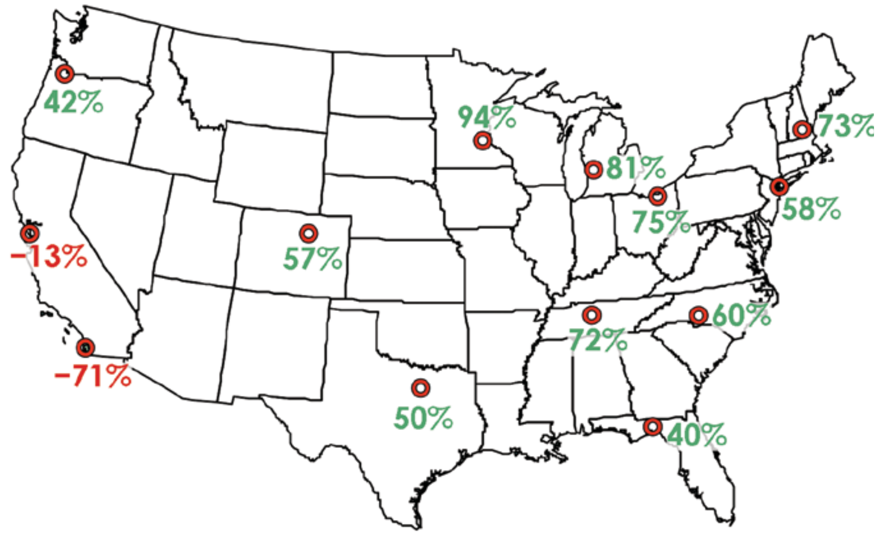

Figure 2. The estimated increase (in green) or decrease (in red) in heating costs by growing petunia 'Easy Wave Coral Reef' at 58°F instead of 68°F for first flowering on April 1 given our virtual greenhouse characteristics. In this example, the increase in energy consumption is because crop timing is extended by 32 days when grown at 58°F compared to 68°F. See Table 2 for calculations on energy consumption using Virtual Grower.

greenhouse heating costs are (in many locations) higher earlier in the year. As Table 2 indicates, heating costs are lower later in the spring.

An important consideration we will not address in this series is the opportunity cost when growing a crop slowly and at a cool temperature. Because crop timing is longer when grown cool, fewer crop turns are possible, and there is a greater likelihood of other problems occurring (such as a pathogen outbreak). This means overhead costs must be allocated to fewer crops at low production temperatures. An advantage of growing cooler is when light conditions are limiting, crop quality is often higher. These calculations reflect the most rapid development rate. A decision must be made between optimum energy use and crop quality.

Starting next month, we will present crop timing data and will use Virtual Grower to estimate heating costs in different locations. Of course, fuel costs depend on numerous factors. To make comparisons, we will use the same virtual greenhouse throughout this series. See Table 2 for some of our virtual greenhouse parameters. **GG**

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