Minimize BEDDING PLANT to offset high

The fewer days your crops are in the greenhouse, the less you have to pay to heat them.

By Ryan M. Warner

High fuel prices are turning up the heat on our industry, forcing growers to produce crops more efficiently to maintain a profit. Additionally, growers are under increasing pressure to deliver a uniform flowering product on a particular date. These trends make it critical to understand the factors that impact crop timing to ensure that high-quality crops are delivered on time.

Lowering temperatures to below 68°F delays flowering of *Salvia farinacea* 'Strata' (top) much more than nemesia 'Sunsatia Peach.'

You may not be able to do anything about high fuel prices, but there are steps you can take to reduce crop production time and, therefore, costs. The fewer days your crops are in the greenhouse, the less you have to pay to heat them.

The three factors with the greatest impact on crop timing are temperature, the light environment (daylength and light quantity) and the size of the starter material.

Temperature is key

The primary factor determining how quickly a crop develops is temperature. Leaf unfolding rate (how many leaves unfold each day at a given temperature) is usually referred to when discussing a plant's rate of development.

Generally, leaf unfolding rate increases as temperature increases up to a maximum temperature. When the temperature surpasses the maximum allowed, plants experience stress and the leaf unfolding rate declines.

Easter lily growers have long used the knowledge of how temperature impacts leaf unfolding rate to accurately schedule the plants to flower.

The maximum temperature for leaf unfolding rate is usually not the appropriate temperature for crop production, as crop quality (i.e., flower number and size, lateral branching) begins to decrease at temperatures well below the peak temperature for leaf unfolding rate.

Many growers have been tempted to lower greenhouse temperatures in response to the rise in fuel costs. Lowering temperatures increases crop production time by reducing the leaf unfolding rate. In many cases, the increased production time eliminates any fuel savings a grower was hoping to realize by increasing total fuel costs for that crop. It is important to think how much total fuel is used

PRODUCTION TIME fuel costs

Table 1 IMPACT OF TEMPERATURE ON FLOWERING OF SEED AND VEGETATIVE ANNUALS

Species	57°F	62°F	68°F	73°F	79°F	Delay in flowering (days)	Delay per 1°F (days)
Angelonia 'Angelface White'	68	52	42	35	36	26	2.4
Antirrhinum 'Liberty Bronze'	69	58	51	48	47	18	1.6
Calibrachoa Superbells Pink	42	30	26	23	19	16	1.5
Diascia 'Flying Colors Coral'	38	28	25	23	33	13	1.2
Gazania 'Daybreak Red Stripe'	65	55	49	41	40	16	1.5
Nemesia 'Sunsatia Peach'	41	38	32	47	58	9	0.8
***Salvia farinacea* 'Strata'**	94	72	59	50	50	34	3.1
Viola 'Delta Pure White'	57	50	46	40	41	11	1.0

Days to flower at 57°F-79°F. Table shows delay in flowering as temperature decreased from 68°F to 57°F and delay per 1°F reduction in temperature for several bedding plant crops.

to produce a crop, not just how much fuel is consumed daily.

Temperatures affect production time

An estimated 80 percent of greenhouse heating costs are incurred at night. While substantially lowering average daily temperature should be avoided for most crops, you may consider lowering the night temperature by a few degrees and growing a few degrees higher during the day to maintain the desired average daily temperature. Keep in mind that this will create a positive DIF (difference between day and night temperatures), and promote stretching. While this will increase the amount of growth regulators needed, the increased chemical costs may still be acceptable when compared to the heating cost savings.

How much does lowering the temperature increase crop production time? Although decreasing temperature will increase crop production time, the amount of delay will vary by crop.

Research at Michigan State University looked at how timing of several seed and vegetative annuals responded to temperature. Plants were

Table 2 PHOTOPERIODIC CLASSIFICATION OF BEDDING PLANT CROPS

Long-day plants	Short-day plants	Day-neutral plants
Ageratum	African marigold	*Begonia semperflorens*
Calendula	Bougainvillea	Convolvulus (DLI)
Dianthus chinensis	Celosia	*Dianthus barbatus*
Fuchsia	Cosmos (DLI)	Nicotiana (DLI)
Lavatera (DLI)	Gomphrena	French marigold
Lobelia (blue)	Hiemelis begonia	Geranium (DLI)
Pansy (DLI)	Morning glory (*Ipomoea purpurea*)	Impatiens
Petunia	Sanvitalia	New Guinea impatiens
Rudbeckia	Signet marigold	Thunbergia
Salvia	*Zinnia elegans*	*Zinnia angustifolia*
Snapdragon (DLI)		
Statice		
Sunflower (*Helianthus annuus*)		
Sweet pea (*Lathyrus odoratus*)(DLI)		
Tuberous begonia		

(DLI) refers to species that flower earlier under high daily light integrals.

Flowering of cosmos is greatly accelerated by growing plants under short days.

grown at constant temperatures of 57°F, 62°F, 68°F, 73°F or 79°F under a photoperiod of 16 hours with supplemental high-pressure sodium light. Reducing temperature resulted in much more significant flowering delay for some crops. For example, decreasing temperature from 68°F to 57°F delayed nemesia 'Sunsatia Peach' flowering by only nine days. The same temperature reduction delayed *Salvia farinacea* 'Strata' flowering by 35 days. Flowering of nemesia was delayed and severely reduced when the temperature was above 68°F. Results for several crops are in Table 1 on Page 77.

THE FACTORS WITH THE GREATEST IMPACT ON CROP TIMING:

1. **Temperature**
2. **Light environment (daylength and light quantity)**
3. **Size of starter material**

These results show that it is critical not to cheat on the heat for crops like salvia and angelonia. Other crops adversely affected by low temperatures are vinca, celosia, cleome, cosmos, gomphrena, portulaca and helianthus.

In contrast, alyssum, dianthus, diascia, nemesia, pansy, snapdragon and viola may be grown at temperatures in the low 60s without excessive delay.

Light impacts crop scheduling

While temperature is the driving force behind leaf unfolding rate, photoperiod and total light quantity (daily light integral or DLI) impact crop scheduling by controlling when flower induction occurs.

Many bedding plants are photoperiodic, meaning they flower in response to daylength. Many crops flower earlier when the days are long (see Table 2 on Page 77). If you don't provide supplemental lighting as a night-interruption or a day extension, the natural photoperiod is not long enough to induce flowering in these long-day plants until late March.

An example of this is Wave petunias. Many growers have noticed that Wave petunias will put on excessive vegetative growth without flowering, outgrowing their container or taking over a mixed container, before flowering in late spring. Wave petunias have a very strong requirement for long days. They will flower much earlier if provided with long-day lighting.

Short-day plants such as cosmos and zinnia will flower earlier if grown under short daylengths (less than 12 hours). Taking advantage of a crop's response to photoperiod can dramatically reduce production time and costs.

In addition to photoperiod, some bedding plant crops flower earlier when grown under a high daily light integral. A high daily light integral can impact crop timing in two ways. First, flowering occurs earlier in development (i.e., the plant forms fewer leaves below the first flower) for some crops. Second, a high daily light integral will increase plant temperature, which increases the leaf unfolding rate.

Starting material size matters

Have you ever found yourself in a situation where you are producing plugs in a small amount of greenhouse space, but have to heat the entire greenhouse? If you are heating a whole greenhouse section, but only using a part of the space to produce plugs, you may consider buying plugs from an outside source. The amount of money you save by not heating the greenhouse when outside temperatures are lowest may offset the cost of buying plugs.

If you already buy plugs, consider buying in larger starting material. Plugs are commonly available in sizes from a 512-cell up to 72-cell trays or larger. The larger the plug size you start with, the more mature the plant is, meaning the faster that crop will finish after transplanting.

As a rule of thumb, if the plug size increases from a 512 to a 288, or a 288 to a 128, finishing time is reduced by one week after transplant. Even though larger plugs cost more, the reduced production time may compensate for this expense.

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