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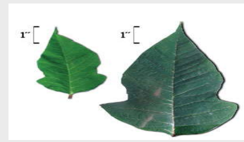
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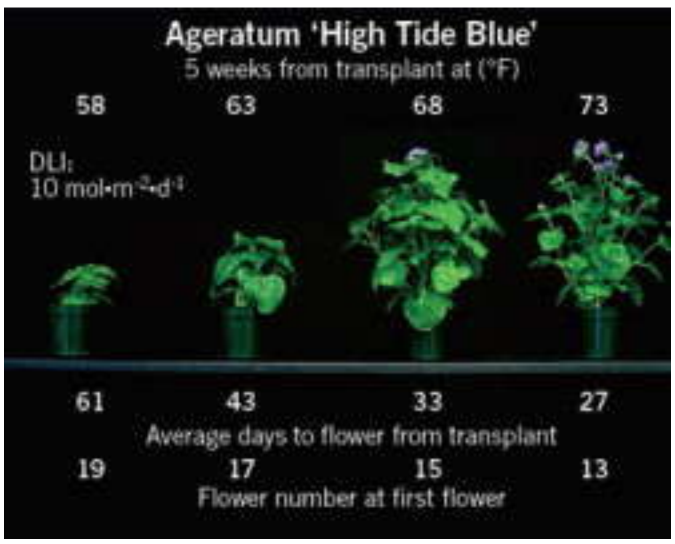
Energy-Efficient Annuals: Ageratum & Cosmos

By: Matthew Blanchard | Erik Runkle

June 19, 2009



Scheduling annual bedding plants in flower for specific market dates is of increasing importance to many greenhouse growers. During the past several years at Michigan State University (MSU), we have performed experiments with many seed propagated annuals to

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quantify how temperature and daily light integral (DLI) influence flowering time and plant quality. In the fifth article of this series, we present information on ageratum and cosmos and then use crop timing data to estimate greenhouse heating costs at different locations, growing temperatures and finish dates.

Materials and Methods

Seeds of ageratum (Ageratum houstonianum 'High Tide Blue') and cosmos (Cosmos sulphureus 'Cosmic Orange') were sown in 288-cell plug trays by C. Raker & Sons, and then grown in controlled environmental growth chambers at MSU at 68°F (20°C). Inside the chambers, the photoperiod was 16 hours and the DLI was 9 to 11 molâˆ™m^{-2}âˆ™d^{-1}.

When plugs were ready for transplant (27 days after seed sow for ageratum and 16 days for cosmos), they were transplanted into 4-inch pots and grown in greenhouses with constant temperature set points of 57, 63, 68 and 73°F (14, 17, 20 and 23°C). At each temperature, plants were grown under a 16-hour photoperiod with two different DLIs provided by a combination of shade curtains and different light intensities from high-pressure sodium lamps.

Ageratum does not require long days for flowering, but plants flower faster if long days are provided. Cosmos 'Cosmic Orange' is a day-neutral plant and flowers in the same time if provided with short or long daylengths. However, some cosmos varieties flower faster when grown under short days.

The experiment was performed twice to obtain average DLIs that ranged from 3 to 19 molâˆ™m^{-2}âˆ™d^{-1}. To give perspective, a DLI of 3 molâˆ™m^{-2}âˆ™d^{-1} is received in a northern greenhouse on a cloudy day in the winter. A DLI of 19 molâˆ™m^{-2}âˆ™d^{-1} is typical for a mid- to late spring day. The flowering date was recorded for each plant when ageratum had two open flowers and petals of cosmos were fully reflexed. When each plant flowered, plant height, number of leaves and branches and

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number of flowers and flower buds were recorded.

Crop timing data was used to develop mathematical models to predict flowering time and plant quality under different temperature and DLI conditions. The scheduling models were validated by growing ageratum and cosmos at three different constant temperatures to compare predicted flowering times with actual times. The Virtual Grower software (available free at www.virtualgrower.net) was used to estimate the cost to heat a 21,504 square foot greenhouse (about half an acre) to produce each crop for different finish dates and at different locations in the United States.

Results

In both ageratum and cosmos, time to flower decreased as average daily temperature increased and DLI increased. For example, time to flower in ageratum 'High Tide Blue' grown under a DLI of 10 molâˆ™m^{-2}âˆ™d^{-1} decreased from 61 days at 58°F to 27 days at 73°F (Figure 1). We were a bit surprised by the substantial flowering delay when ageratum was grown cool because many consider it a cool-growing (cold-tolerant) crop. Flowering time of cosmos 'Cosmic Orange' was similar: It decreased from 66 to 31 days as temperature increased from 58 to 73°F (Figure 2).

In both crops, higher light levels accelerated flowering more when plants were grown cool than at warmer temperatures. For example, as DLI increased from 3 to 8 molâˆ™m^{-2}âˆ™d^{-1}, time to flower in ageratum grown at 58°F and 73°F decreased by 15 days and seven days, respectively. There was no acceleration in flowering when the DLI exceeded 10 molâˆ™m^{-2}âˆ™d^{-1} for ageratum and 7 molâˆ™m^{-2}âˆ™d^{-1} for cosmos.

Using this crop timing data, we identified dates that 288-cell plugs need to be transplanted for two different market dates when grown at different temperatures (Table 1).

Temperature and DLI had different effects on the number of flower buds at first flowering in cosmos and ageratum.


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In ageratum, flower bud number was primarily influenced by temperature, whereas in cosmos, flower bud number was primarily influenced by DLI. For example, ageratum had six more flower buds when grown at 58°F versus 73°F (Figure 1). In cosmos, plants grown at 63°F and under a DLI of 15 molâˆ™m^{-2}âˆ™d^{-1} had 15 more flower buds than plants grown at the same temperature, but under 5 molâˆ™m^{-2}âˆ™d^{-1}.

In both crops, as the DLI increased from 3 to 19 molâˆ™m^{-2}âˆ™d^{-1}, the number of lateral branches at flower increased by two to four. Therefore, although plants did not flower faster as DLI increased above 10 molâˆ™m^{-2}âˆ™d^{-1}, plant quality improved because plants had more flowers. Plant height at flower increased as constant temperatures increased from 58 to 73°F. Under a DLI of 10 molâˆ™m^{-2}âˆ™d^{-1}, ageratum and cosmos were 2.6 inches and 5 inches taller, respectively, at a constant temperature of 73°F versus 58°F.

Heating Costs
We can use this crop timing information with Virtual Grower to determine if it is more energy efficient to transplant a crop earlier and grow cool versus transplanting later and growing warm. For example, to produce an ageratum or cosmos crop for April 1 in Grand Rapids, Mich., New York, N.Y., or Cleveland, Ohio, heating costs per square foot would be 27 to 42 percent lower at 73°F versus 58°F (Table 2).

In contrast, to produce these crops for the same market date in Charlotte, N.C., and Fort Worth, Texas, a production temperature of 63 or 68°F would consume the least energy for heating. San Francisco was the only location tested that had lower predicted fuel consumption when crops were transplanted early and grown at 58°F for a market date of April 1.

At some locations, the production temperature that had the lowest heating costs per square foot per crop varied between market dates. For example, ageratum grown for April 1 in New York had the lowest predicted heating costs when grown at 73°F. In contrast, for a market date of May 15, estimated fuel costs were lowest if grown at 63, 68, or 73°F. In this example, because there is no difference in heating costs to produce ageratum for May 15 in New York at 63 to 73°F, other factors such as plant quality, availability of labor, overhead costs and opportunity costs could be considered when selecting a growing temperature.

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