Using Flowering and Heat-Loss Models for Improving Greenhouse Energy-Use Efficiency in Annual Bedding Plant Production

Traditionally, energy for greenhouse heating has been the second largest indirect production cost for growers in temperate climates with labor being the first. Annual bedding plant crops are typically produced in heated greenhouses from late winter through spring. Temperature, photoperiod, light intensity, and transplant date are commonly manipulated during commercial production so that plants are in flower for predetermined market dates. The length of production time for bedding plants varies by species and cultivar and can depend on the maturity and conditions during propagation, application of regulating chemicals, desired finish size, mean daily temperature (MDT), photosynthetic daily light integral (DLI), and photoperiod.

In this study, nine flowering models that predict the effect of mean daily temperature on time from transplant until first flowering was used. Virtual Grower was used to estimate greenhouse heating costs based on user-defined inputs such as building material, construction style, temperature set point, heating system, and typical weather at the selected locations. The temperatures and transplant dates that consumed the least amount of energy for heating, were estimated for two market dates (March 15 and May 1) and three U.S. locations (MI, NY, and NC).

Predicted flowering time decreased as temperature increase from 15 to 24°C (Table 1). More energy required to heat greenhouse to a higher temperature but production time was shorter (Figure 2). Heat inputs higher for March 15 than May 1 and cost greater in MI than NC (Figure 3). This kind of analysis allows the determination of the most energy-efficient production schedule for greenhouse- and crop-specific situations.

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Table 1. Predicted days to first flowering from transplant of nine bedding plant crops produced at four mean temperatures in a double-polyethylene greenhouse in MI.

Species	Mean temperature (°C)				Delay at
	15	18	21	24	15 vs. 21°C
Angelonia angustifolia 'Serena Purple'	85	54	39	31	118%
Antirrhinum majus 'Montego Burgundy'	39	32	27	23	46%
Begonia semperflorens-cultorum 'Sprint Blush'	55	41	33	27	67%
Browallia speciosa 'Bells Marine'	96	64	48	39	98%
Catharanthus roseus 'Viper Grape'	90	49	34	26	167%
Dianthus chinensis 'Super Parfait Raspberry'	68	54	44	38	54%
Pelargonium ×hortorum 'Florever Violet'	89	68	56	47	60%
Petunia ×hybrida 'Fantasy Blue'	28	22	19	16	50%
Petunia ×hybrida 'Easy Wave Coral Reef'	46	33	26	21	78%

Figure 2. Cumulative energy required to heat a 1,000 m^2 double-polyethylene greenhouse in MI or NC to produce a crop of Pelargonium at 15 or 21°C for a 15 March finish.

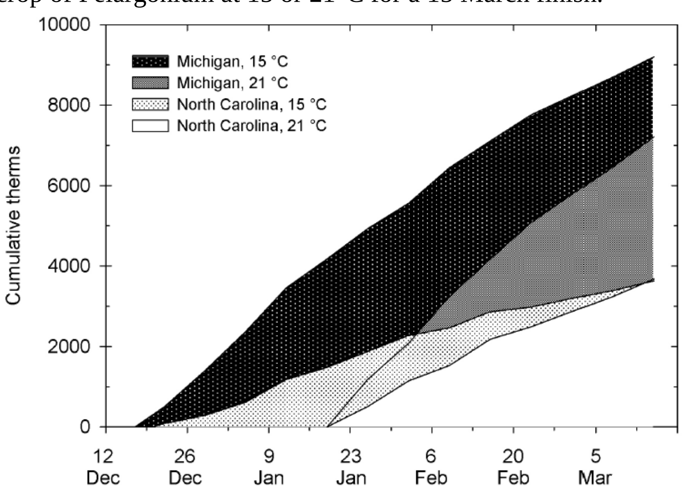
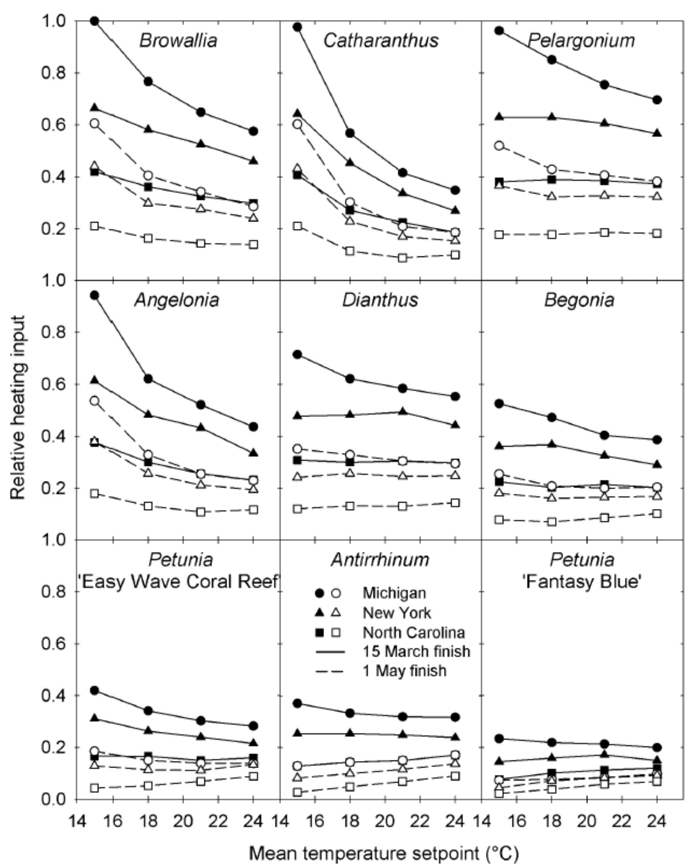


Figure 3. Relative amount of energy required to heat a 1,000 m^2 double-polyethylene greenhouse to produce nine bedding plant crops at four mean temperatures for two finish dates in MI, NY, and NC.



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