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Committee on controlled Environment Technology and Use
2002 Annual Report

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New Facilities Planned

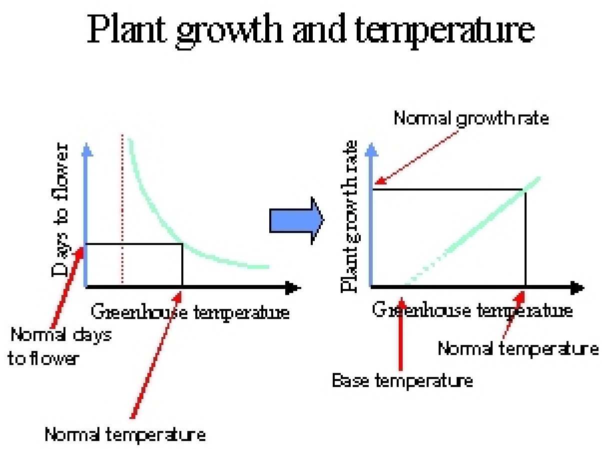
Michigan State University received an NSF major Research Instrumentation grant for $600K, which combined with an MSU match, will allow us to purchase $960K of growth chambers during 2002 to 2004 for plant science research. Old chambers have been removed to open space for new chambers. The first purchase planned is for 12 general-purpose reach-in chambers (15+ ft^2) and 6 reach-in chambers specifically designed for Arabidopsis. Additional, and probably more specialized, chambers will be purchased during a second round. When completed, there will be ≈160 growth chambers for use by MSU plant science faculty. A management plan is being developed to bring all these chambers under the assignment and maintenance direction of one person and set of policies.

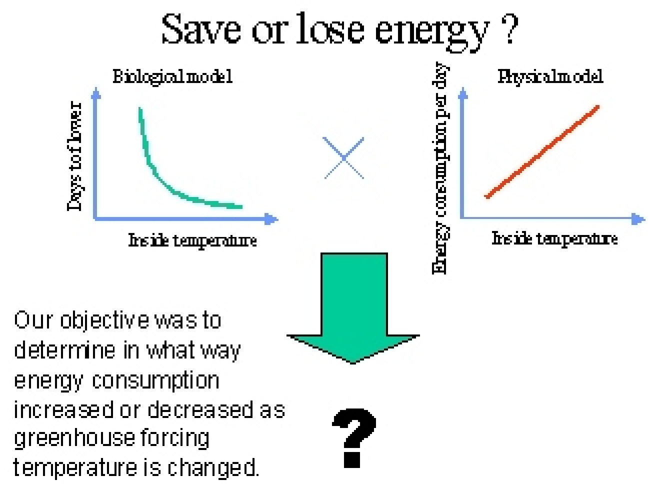
Unique plant responses

The floriculture program at MSU has a program of systematically identifying the floral induction requirements for commercial herbaceous perennials. Most plants require one or more environmental stimuli for flowering: a particular photoperiod, a cold treatment (vernalization), or both. While every plant has some minimal photosynthetic daily light integral (DLI) necessary for flowering, over 200 species we have researched flower (to some extent) following an inductive photoperiod or inductive cold treatment under a DLI of ≈ 5 mol m^{-2} day^{-1}. One exception has been *Digitalis purpurea* 'Foxy', which requires a DLI of ≥ 10 mol m^{-2} day^{-1} for 100% of a population to flower; none flower with 5 mol m^{-2} day^{-1}. This high DLI requirement explains the difficulty many individuals have experienced when trying to flower *Digitalis* for garden shows in mid winter, even under supplemental HPS lighting where the natural light plus supplemental lighting DLI may still be < 10 mol m^{-2} day^{-1}.

The increase in natural gas prices during the winter of 2000-2001 forced many greenhouse growers to consider lowering greenhouse temperature to reduce heating costs. A frequent question asked by growers was the impact of a temperature decrease on crop timing. Knowing that a reduction in temperature would result in an increase in crop duration in the greenhouse, we asked how a reduction in temperature would impact total energy consumption, the sum of the daily lower energy usage integrated over the total longer duration of crop production.

Two models are necessary to answer this question. First, a biological model relating crop development versus temperature is required, and second, a physical model relating energy usage in a greenhouse structure as a function of greenhouse properties and weather conditions.

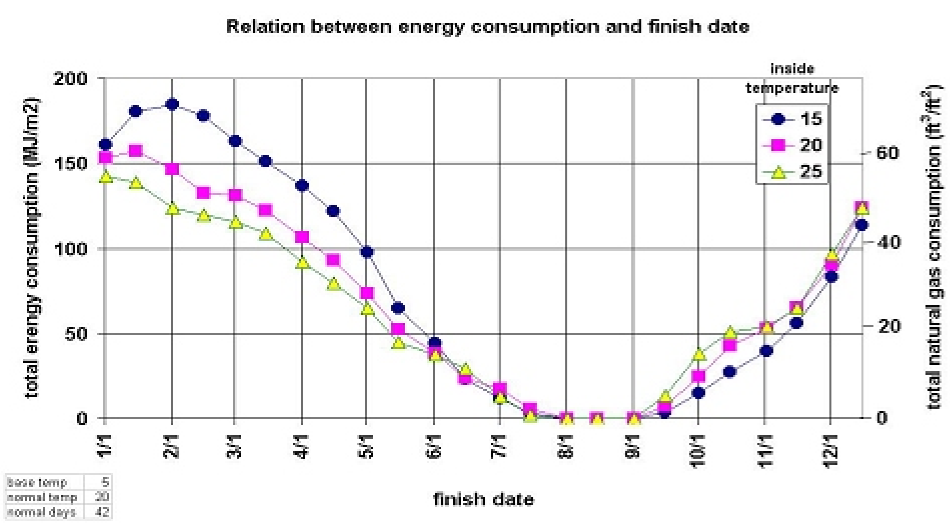




The generally accepted model relating plant development rate and temperature is that development rate increases as a linear function of temperature from the base temperature to the optimum temperature. A linear increase in development rate converts into a nonlinear relationship between total development time and temperature. This means that as temperature decreases in constant increments, development time increases at an increasing rate.

Analysis of the two models showed that energy consumption decreases in a linear fashion while time to flower increased exponentially as temperature decreased. Would lowering temperature decrease total energy consumption of a crop?

Simulated results



The simulations showed that for a crop with a base temperature of 5ºC and normally grown at 20 ºC, lowering the temperature to 15 ºC would actually increase energy consumption for the crop during the spring of the year. This is due to a longer crop time, which occurs during relatively cold days of the year. The assumption in this modeling is that the added time to produce a crop at a lower temperature must be added to the beginning of the crop, not the end, since sales on a particular date is assumed. In contrast, raising the temperature actually decreases energy consumption per crop in the spring, although not in the fall.

2001 Publications

Clough, Emily A., Arthur C. Cameron, Royal D. Heins, William H. Carlson. 2001. Growth and development of *Oenothera fruticosa* is influenced by vernalization duration, photoperiod, forcing temperature, and plant growth regulators. J. Amer. Soc. Hort. Sci. 126(3):269-274.

Hayashi, Takahiro, Royal D. Heins, Arthur C. Cameron, William H. Carlson. 2001. Ethephon influences flowering, height, and branching of several herbaceous perennials. Scientia Horticulturae 91:305-323.

Niu, Genhua, Royal D. Heins, Arthur Cameron, Will Carlson. 2001. Temperature and daily light integral influence plant quality and flower development of *Campanula carpatica* 'Blue Clips', 'Deep Blue Clips', and *Campanula* 'Birch Hybrid'. HortScience 36(4):664-668.

Niu, Genhua, Royal D. Heins, Arthur C. Cameron, William H. Carlson. 2001. Day and night temperatures, daily light integral, and CO2 enrichment affect growth and flower development of *Campanula carpatica* `Blue Clips'. Scientia Horticulturae 87(1-2):93-105.

Runkle, Erik S., Royal D. Heins. 2001. Specific functions of red, far red, and blue light in flowering and stem extension of long-day plants. J. Amer. Soc. Hort. Sci. 126(3):275-282.

Runkle, Erik, Royal Heins, Arthur Cameron, William Carlson. 2001. Horticultural flowering of herbaceous perennials. Flowering Newsletter 31:34-43.

Runkle, E. S., R. D. Heins, A. C. Cameron, W. H. Carlson. 2001. Photocontrol of flowering and stem extension of the intermediate-day plant *Echinacea purpurea*. Physiologia Plantarum 112:433-441.

Whitman, Catherine M., Royal D. Heins, Roar Moe, Keith A. Funnell. 2001. GA4+7 plus benzyladenine reduce foliar chlorosis of *Lilium longiflorum*. Scientia Horticulturae 891:43-154.

Fausey, Beth, Arthur Cameron, Royal Heins. 2001. Herbaceous Perennials: Noteworthy Plants. Greenhouse Grower 19(3):92-96.

Fausey, Beth, Erik Runkle, Art Cameron, Royal Heins, Will Carlson. 2001. Herbaceous Perennials: Heuchera. Greenhouse Grower 19(6):50-62.

Joeright, David, Cathy Whitman, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous Perennials: Plant Growth Regulators. Greenhouse Grower 19(8):84-96.

Joeright, David, Dan Tschirhart, Royal Heins, Arthur Cameron, Will Carlson. 2001. Herbaceous Perennials: Propagation. Greenhouse Grower 19(4):38-45.

Niu, Genhua, Erik Runkle, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous Perennials: Light. Greenhouse Grower 19(1)134-143.

Niu, Genhua, Royal Heins, Will Carlson. 2001. Keeping freedom under control. Greenhouse Grower 19(10):88-96.

Niu, Genhua, Thomas Griffing, Erik Runkle, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous perennials: Ceratostigma plumbaginoides. Greenhouse Grower 19(12):96-100.

Niu, Genhua, Erik Runkle, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous perennials: Pachysandra terminalis. Greenhouse Grower 19(13):86-90.

Runkle, Erik and Royal Heins. 2001. Timing Spring Crops. Greenhouse Grower 19(4):64-66.

Runkle, Erik, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous perennials: Phlox subulata. Greenhouse Grower 19(9):80-85.

Runkle, Erik, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous perennials: Scabiosa columbaria. Greenhouse Grower 19(10):70-76.

Whitman, Cathy, Beth Fausey, Erik Runkle, Royal Heins, Art Cameron, Will Carlson. 2001. Herbaceous perennials: Oxalis crassipes 'Rosea'. Greenhouse Grower 19(14):77-84.