Young Plant Research Center

Flowering time of bedding plants in different greenhouse locations

By Paul Fisher (pfisher@ufl.edu), University of Florida,
John Erwin (erwin001@umn.edu), University of Minnesota,
Matt Blanchard (mgblanch@msu.edu) and Erik Runkle (runkleer@msu.edu), Michigan State University

- **Objective:** To measure time to flower under different greenhouse conditions, and evaluate whether temperature or light affect flowering time for several bedding plant species during the spring.

- **Benefit:** The benefit will be to validate scheduling tools for partner growers and their customers. These tools will show the effect of greenhouse climate on finishing time, in order to help consistently achieve target market dates.

  A degree-day model assumes that flowering is affected by temperature only, and that plants flower more quickly at warm temperatures (up to a certain high temperature limit). We are developing degree-day models at the University of Minnesota (UMinn), Michigan State University, and University of Florida (UF) for seed- and vegetatively-propagated bedding plants. This model has been packaged as a spreadsheet tool for predicting flower time at different temperatures. In this trial, we wanted to see whether temperature alone adequately predicted flowering time at different greenhouse locations under spring bedding plant conditions, or whether light also had a major effect.

  Weather stations to measure air and soil temperatures, relative humidity and light level were installed in several greenhouse locations around the U.S. to will provide consistent climate data.

  Two experiments were run. Liners of Angelonia ‘Angelface Blue’, Osteospermum ‘Soprano Purple’, and Calibrachoa ‘Superbells Red’ were rooted at one location, Pleasant View Gardens. Liners of Petunia ‘Cascadia ‘Champagne’ were rooted in a second location, D.S. Cole Growers also in Loudon NH. These rooted liners were then shipped to 15 grower locations and three universities. Liners were potted up into 4.5-inch azalea pots, and date of flowering was recorded.

Experimental design:

Experiment 1 (Petunia). Phase 1, Preparing Liners At D.S. Cole Growers In N.H.:

- On week 11 (Mar 12) a single vegetative petunia cultivar (Cascadia ‘Champagne’ which is a trailing medium-vigor cultivar) was stuck at one location (D.S. Cole Growers) in 25-count strip trays with Preforma growing medium (supplied by Pleasant View Gardens)..
- A weather station (provided by UF) was placed in the same greenhouse at D.S. Cole Growers where the trays were located, and measured average temperature and daily light integral.

- Until week 14 (Apr 2) plants were grown under natural day lengths. No growth regulators were applied while liners were being rooted at D.S. Cole Growers, and plants were not pinched.
- On week 14 (Monday, Apr 2), the liners were shipped to each grower and university location.

<u>Experiment 2 (Angelonia, Calibrachoa and Petunia) Phase 1, At Pleasant View Gardens:</u>

- On week 11 (Mar 12): 19 x 25-strip trays of Preforma per cultivar of Angelonia 'Angelface Blue', Osteospermum 'Soprano Purple', and Calibrachoa 'Superbells Red' at Pleasant View Gardens, Loudon NH, were stuck with unrooted cuttings.
- From week 11 to 15 (Mar 12 to Apr 9): Plants were grown at Pleasant View Gardens under natural day lengths.
- The weather station (provided by UF) was placed in the same greenhouse(s) at Pleasant View Gardens where the trays were located. From week 11 to 15 (Mar 12 to Apr 9), daily light and temperature data were downloaded weekly onto a data sheet (provided by UF).
- From week 11 to 15 (Mar 12 to Apr 9): Fertilizer, growth retardants, and pesticides were recorded on a crop record sheet (provided by UF). Plants were not pinched.
- On Week 15 (Apr 9), plants were shipped to 16 greenhouse locations, plus UMinn, MSU, and UF. Each site received one mixed 75-count tray made up of a 25-count split tray of each of the three cultivars as rooted liners.

<u>Both Experiments, Phase 2, At Each Grower Location On Receiving Rooted Liners</u>

- Growers were supplied with:
  - A data logger to record air temperature and light level (provided in January)
  - An Excel spreadsheet and paper data sheet to enter air temperature and light level (provided in January)
  - Labels for each pot
  - A crop record sheet to record dates for growth retardant applications and transplant, and fertilizer concentration
  - An Excel spreadsheet and paper data sheet for entering heights and flowering dates
- Growers provided:
  - 24 x 4.5-inch-diameter azalea pots
  - Six spacer trays for the 4.5-inch pots (plants will be grown double-spaced)
- A week after receiving the liners, growers transplanted 8 x 4.5-inch pots per cultivar with a label in each pot (provided by UF). All plants were pinched to a height of 2-inches on the same day that liners are transplanted. Transplant date was recorded in the crop record sheet. The plants were grown double-spaced in the greenhouse under natural day lengths, where the temperature and light data logger was placed. Plants were checked twice a week, and the date when each plant first had an open flower was recorded.

Results

Average air temperature during the study period of April to June ranged between greenhouse locations from 59 to 76^{o}F, and daily light integral ranged from 9 to 41 moles/m^2/day. For the greenhouses in this study, there was no correlation between air temperature and light level (data not shown). Some greenhouses therefore had low temperature and high light, for example Altman Plants in southern California, or warm temperature and moderate light level (e.g., northeastern locations).

In both experiments, average greenhouse air temperature had a big effect on days to flower. At warm temperatures, plants flowered more quickly. In contrast, daily light integral did not affect days to flower.

At a given temperature, most greenhouses were within ±7 days of the average flowering time. Therefore, the best a degree day model is likely to reliably do is predict flowering time within ±7 days.

These results lend support to the use of degree day models for predicting flowering time of bedding plants across a range of locations, at least in the range of light levels (more than 9 moles/m^2/day) from this trial.

However, when light is very low (below 10 moles/m^2/day), research has shown that delay in flowering can occur, so in winter conditions in the northern U.S. light level will be limiting to flowering time in many crops and a degree day model may be inaccurate. During spring through fall periods, however, light level should be adequate to use degree day models.

The figure below shows an example of a degree day model packaged in a spreadsheet tool. The grower selects from a list of crop species, in this case petunia. They enter the normal production time under their normal growing conditions, in this case 40 days at 65^{o}F. The degree day model predicts the flowering time under different temperature conditions, ranging from 70 days at 54F to 24 days at 82F for this set of assumptions.

Greenhouse Temperature Effect on Crop Scheduling.

Paul Fisher, University of Florida; John Erwin, University of Minnesota, Erik Runkle and Matt Blanchard, Michigan State University.

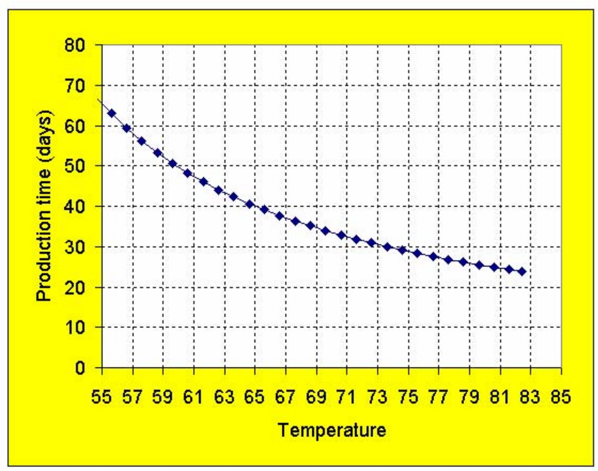
Young Plant Research Center

Species:	Petunia
Normal production time (days):	40
Normal production temperature (F):	65
Temperature units (C or F):	F

Update Chart

Expected production times

F	C	Days
54	12.2	70
60	15.6	50
65	18.3	40
70	21.1	34
75	23.9	29
82	27.8	24



This is a guide only.
Confidence in model estimates decreases the more temperature varies from normal production temperature.
Production times typically vary by ± 7 days between greenhouse locations at the same temperature.
When changing temperature units, click on the grey Update Chart button.

Figure 1. Summary of locations, temperature, light level and flower time for petunia from Experiment 1.

Growth regulators: Days to Flower for control plants only, including temperature and light levels.

Young Plant Research Center

Treatment	Altmans	Smith	Wagners	U. Minn.	Glass C	Four S	Center	Welby	PVG	DS Cole	Costa	UF
Days to Flower	59	43	45	41	32	41	51	41	46	46	37	37
Average Daily Temperature (F)	59	66	67	70	69	65	65	65	68	64	73	74
Daily Light Integral (mol/m^2/d)	39	16	16	25	10	20	19	18	14	9	24	17

Days to flower varied from 32 to 59 days depending on location.

Air temperature was coolest in Altmans (Cal.) and warmest in the two Florida locations. Light level was highest in Altmans (Cal.) and lowest in Glass Corner and N.H. greenhouses.

Flowering occurred more quickly at warm air temperature, but was not affected by light level.

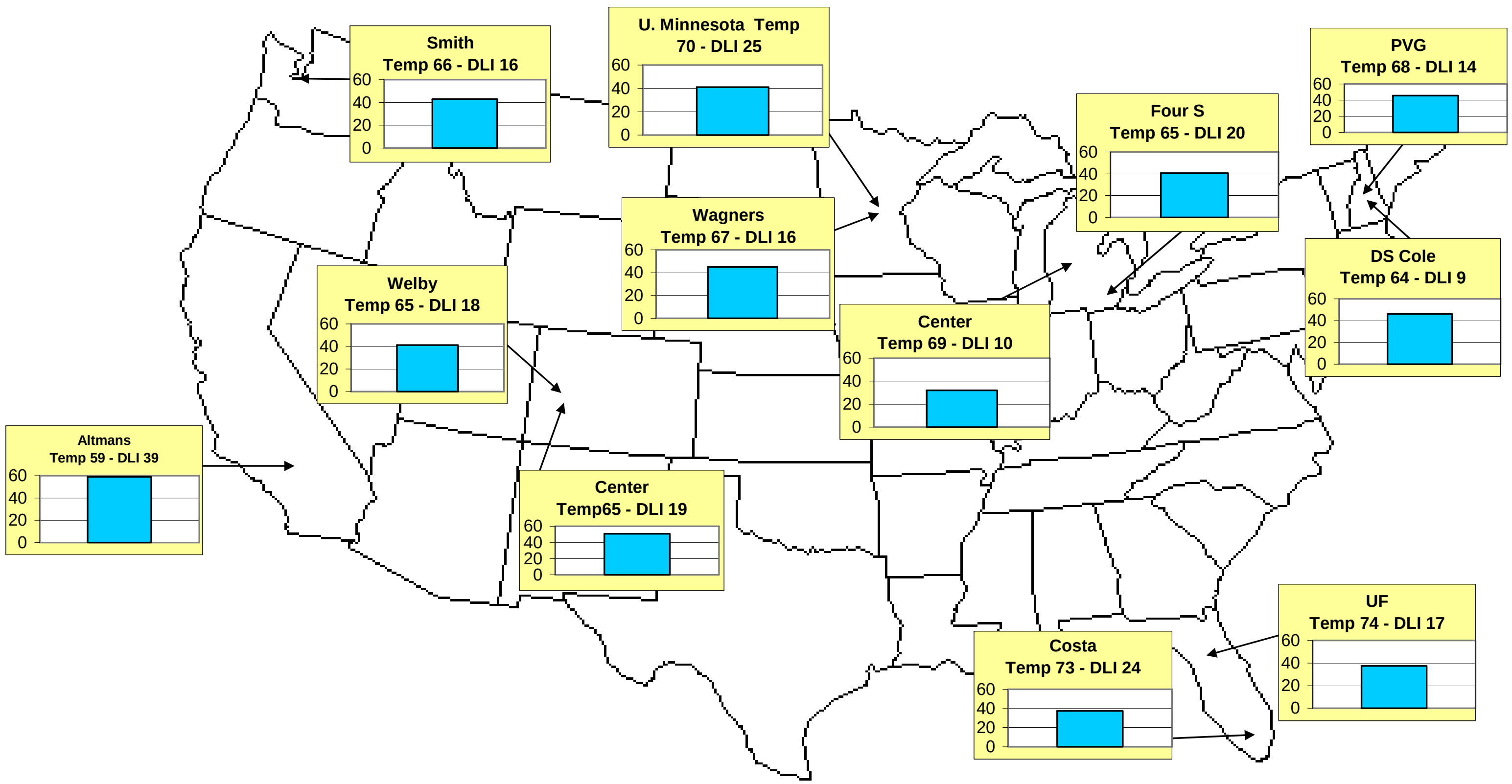


Figure 2. Effect of air temperature (left chart) and daily light integral (right chart) on flowering time of petunia in Experiment 1.

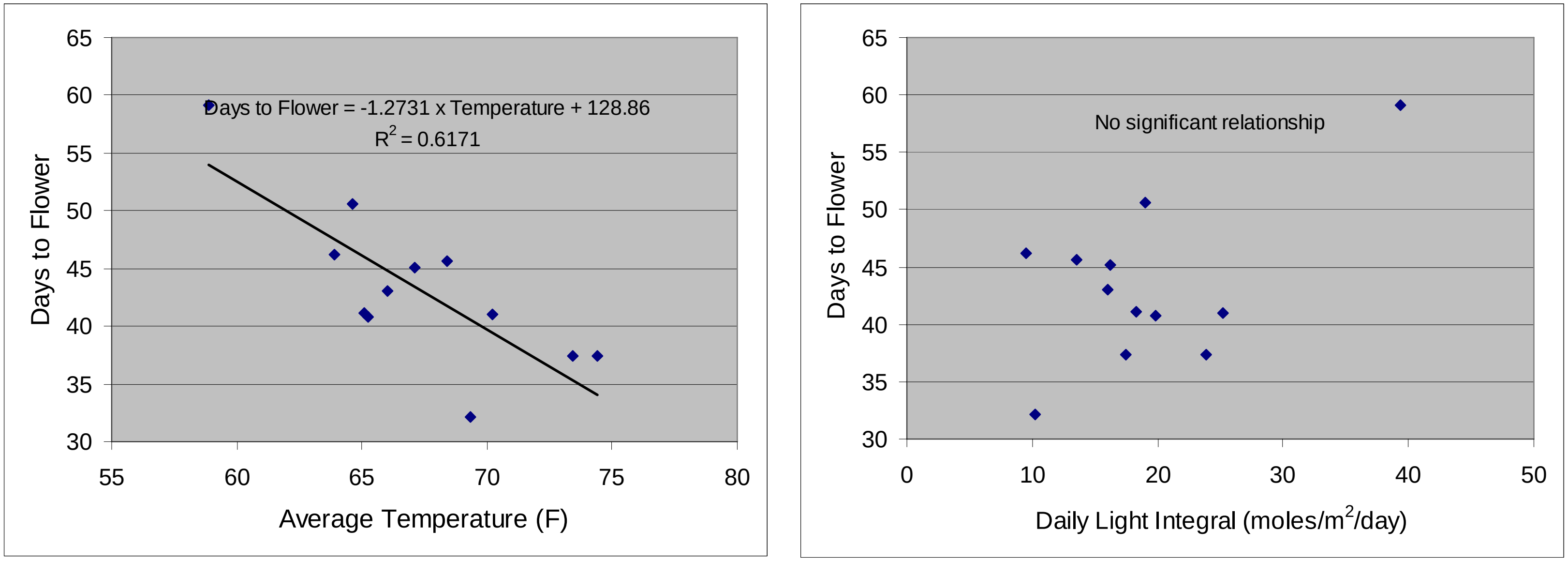


Figure 3. Effect of air temperature on flowering of Angelonia (left), Calibrachoa (middle), and Osteospermum (right) in Experiment 2.

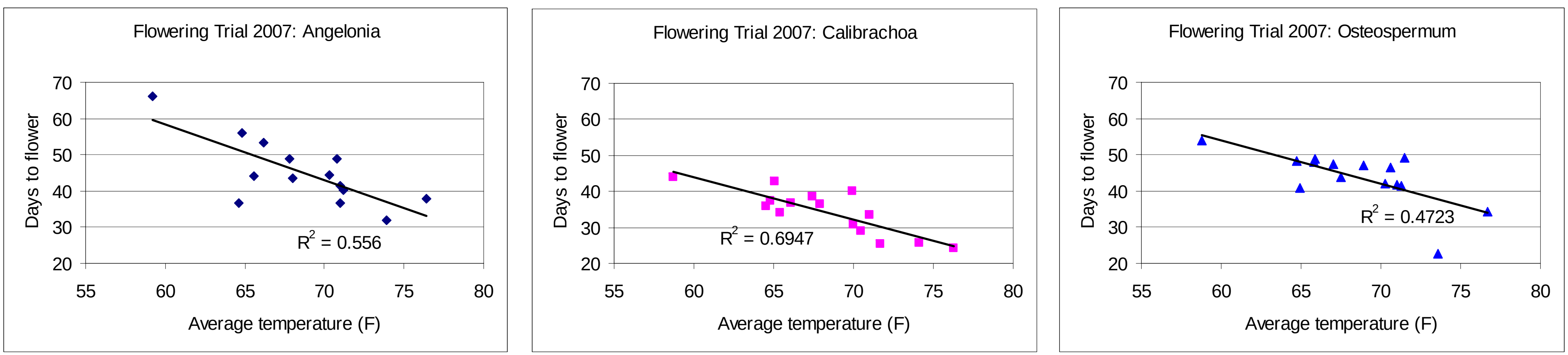


Table 1. Summary of days to flower for Experiment 2.

		Altman	Center	Costa	DS Cole	Four Star	Gl Corner	Henry Mast	MSU	PVG	Post	Smith	U Minn	UF	Wagnr	Welby
Flower Date	Angelonia	6/16	6/6	5/12	6/3	5/25	5/17	5/29	5/21	5/24	5/22		5/25	5/19	5/30	5/17
	Calibrachoa	5/24	5/18	5/6	5/23	5/15	5/10	5/21	5/14	5/17	5/6	5/17	5/11	5/5	5/19	5/16
	Osteo	6/4	5/29	5/3	5/29	5/29	5/30	5/27	5/22	5/28	5/22	5/28	5/23	5/15	5/24	5/21
Days to Open Flower	Angelonia	66	56	32	53	44	37	49	40	43	42		44	38	49	37
	Calibrachoa	44	38	26	43	34	29	40	34	36	25	37	31	24	39	36
	Osteo	54	48	23	49	48	49	47	42	47	42	47	42	34	44	41

Table 2. Summary of temperature and light level for Experiment 2

	Altman	Center	Costa	DS Cole	Four Star	Gl Corner	Henry Mast	MSU	PVG	Post	Smith	U Minn	UF	Wagnr	Welby
Average Temp (^{o}F)	59	65	74	66	66	71	70	71	68	71	67	70	76	68	65
Daily light Integral (moles/ m^2/ day)	41	20	27	14	21	14	20	15	14	24	16	25	17	16	20