# GROW BETTER BEDDING PLANTS IN COLD WEATHER

## Researchers evaluate the pros and cons of high tunnels versus heated greenhouses.

by **CHRISTOPHER J. CURREY, ROBERTO G. LOPEZ** and **NEIL S. MATTSON**

BEDDING production begins in mid- to late-winter and early spring in the northern half of the U.S., when outdoor air temperatures and light are at seasonally low levels. During this time, greenhouses must be heated to maintain desirable production temperatures.

The costs involved can be huge. Energy for heating in northern climates accounts for 10 to 30 percent of the total operating costs of commercial greenhouses. So it makes sense to find alternative strategies.

Our research shows that high tunnels are a viable alternative for plant producers. High tunnels are an unheated polyhouse or hoop house covered with a single layer of plastic, although a double layer of plastic or additional covering inside may be used. In floriculture, high tunnels are most commonly used in cut-flower production for season extension and protection against frost, rain and wind. They are also used to produce and overwinter containerized herbaceous and woody perennials.

These structures are not designed to be equivalent to greenhouses for year-round protected crop cultivation, but they provide a semi-protected environment. When compared to outdoor production, crop cultivation in high tunnels can take place earlier in the spring and later into the fall. These tall structures also provide more uniform temperatures compared to a cold frame.

Traditionally, high tunnels are not heated or wired for electricity. This varies

**The *Dianthus* 'Super Parfait Raspberry' on the left was grown in a high tunnel. Its counterpart was greenhouse grown.**

## How This Study Was Conducted

Two locations participated: Cornell University in Ithaca, N.Y., and Purdue University in West Lafayette, Ind., both in USDA Zone 5b. Plugs and rooted liners of cold-tolerant plants included: *Dianthus* 'Super Parfait Raspberry,' *Tagetes* 'Janie Deep Orange' French marigold, *Osteospermum* 'Zion Copper Amethyst,' *Petunia grandiflora* 'Single Dreams Midnight,' *Antirrhinum* 'Dragon Buttery' and *Viola* 'Penny Lane Mix.'

Cold-temperate plants tested were *Pelargonium* 'Pinto Red' and *Lobelia* 'Cascading Techno Heat Dark Blue.' Cold-sensitive plants were *Angelonia* 'Serena Lavender,' *Celosia* 'New Look' and *Vinca* 'Cooler Grape.'

### Fertilizers Also Studied

In the experiment, use of controlled-release fertilizers (CRFs) was evaluated. If effective, CRFs would allow those finishing spring annuals to avoid designating a fertilization injector and labor for mixing fertilizers. The rate of fertilizer release from CRFs is temperature-dependent, so CRFs were tested in two temperature environments: a heated greenhouse and an unheated high tunnel with more variable temperature fluctuations throughout the day.

On April 1, 2012, forty plugs of each species were transplanted into 4-inch round containers filled with a peat-perlite substrate at each location. From this point, 20 transplants of each species were randomly designated as CRF treatment, and 2.5 grams per pot of CRF was top-dressed on the surface of the substrate. The remaining 20 transplants were designated as the water soluble fertilizer (WSF) treatment and were irrigated as necessary with clear water and 400 parts per million of nitrogen from a balanced water-soluble fertilizer was applied once per week.

### Growing Conditions

Ten plants from each fertilizer treatment were moved to glass-glazed greenhouses with constant air temperature set points of 65°F, while the remaining ten plants from each fertilizer treatment were moved to an east-to-west-oriented high tunnel. Although we didn't manage temperature as actively as a regular greenhouse, we did modulate temperature in the high tunnel.

At Purdue, ventilation was provided by end-wall peak vents and roll-up side walls, though vents and walls were closed during periods of high winds. During periods when air temperature was above 40°F and winds were calm, the high tunnel doors and vents were left open.

At Cornell, ventilation was achieved using an electronic motor to roll side walls up or down based on a thermostat. A thermostat within the high tunnel was automated to temperature set points of 85°F to roll up the side wall and 62°F to roll it down.

from operation to operation. Emergency heat may be provided with a salamander or other portable unit heaters. Ventilation is provided by rolling up the sides manually or with an electric motor.

The low capital investment for a high tunnel and the elimination of fuel consumption for heating may make it feasible and profitable to finish cold-tolerant spring annuals with a relatively short crop time in northern latitudes.

This study quantifies the growth and chilling sensitivity of several cold-tolerant, temperate and sensitive bedding plant crops with two fertilizer regimes at northern latitudes grown in an unheated high tunnel compared to a traditional greenhouse.

**Grandiflora petunia 'Single Dreams Midnight' was grown in a high tunnel and fertilized with controlled-release (left) or water-soluble fertilizer (right).**

### High-Tunnel-Grown Plants Flower Later

Three days after planting, the temperature dipped to 21°F in the high tunnels at Purdue. As a result, only dianthus, pansy, petunia and snapdragons survived. When we replanted all the species at Purdue and placed them in the high tunnel one week later, however, all species survived and were marketable.

At Cornell the temperature dropped to only 27°F in early April in the high tunnel. The marigolds were a complete loss and 50 percent of the angelonia and celosia were lost. All other plants at Cornell survived.

Plants grown in high tunnels flowered zero to 20 days later than plants grown in greenhouses, depending on the crop and location. At both Cornell and Purdue, there was no delay in flowering for pansy finished in the high tunnel. Angelonia and snapdragons grown in the high tunnel were the most delayed and flowered about two to three weeks later than those grown in the greenhouse. The other crops were generally only delayed by about one week (five to nine days) when finished in the high tunnel.

Overall, dead plants were generally cold-sensitive, including angelonia, celosia and vinca. However, cold-temperate

(geranium) and cold-tolerant crops (French marigolds) also died in the cold weather at Purdue. This may have been due to a lack of acclimating plugs and liners with reduced temperatures before planting out in the high tunnel.

One of the most interesting discoveries was the effect of growing location on stem length. Several species were more compact when grown in high tunnels compared to the plants grown in the greenhouse at 65°F. According to the environmental data, the coldest temperatures were generally at dawn. Therefore, we postulate that the cold temperatures at the beginning of the day acted as a morning temperature dip, which can reduce or eliminate the need for growth regulators on many crops and acts similar to a negative difference between the night temperature and the day temperature (DIF) in terms of regulation of stem extension. Therefore, plants produced in the high tunnels were generally equal or improved in quality compared to greenhouse-grown plants.

We did not find any consistent, distinct effects of CRF or WSF fertilizer on bedding plant production time, size or quality. This indicates that there is some latitude for how to apply fertilizers to bedding plants grown in high tunnels. One advantage with CRFs is that as long as the substrate is moist, nutrients remain available for plant uptake. This may be useful for those times when overcast or cool conditions may decrease the frequency of WSF application.

## Keep High Tunnel Plants Warm To Avoid Problems

After looking at the results for some plants from the Purdue site, the idea of having plants in an unheated high tunnel should scare you. Fortunately, there are a few different options you have that may mitigate some of the risk involved with this type of production.First, it is possible to use a small, portable propane heater to add some heat. Be careful to ensure the burner is operating efficiently, though. An off-gas, ethylene, can cause flowers to drop and lead to distorted growth. Additionally, Reemay fabric may be useful in pulling over the plants in the evening. Staggered planting dates may help account for variation in species sensitivity to temperatures. Cold-sensitive species such as celosia and vinca could be planted at a later date and grown when the temperatures have increased. **GG**

Christopher Currey (**ccurrey@purdue.edu**) is a graduate student at Purdue University; Roberto Lopez (**rglopez@purdue.edu**) is an assistant professor and Extension specialist at Purdue University; Neil Mattson (**neil.mattson@cornell.edu**) is an assistant professor and Extension specialist at Cornell University. Lopez and Mattson are members of the Floriculture Sustainability Research Coalition. Special thanks to Raker, Everris, ISDA and Fafard for supporting this research.