Grower 101: Growing Plants Cooler, Part II

Weigh the pros and cons of lowering greenhouse temperatures and learn the effect it will have on crop quality, timing and pest and disease control.

By John Erwin, Charlie Rohwer and Ryan Warner

In Part I (*GPN* September 2004) we discussed what happens to plant growth when we grow crops cooler. Here, we will discuss how dropping temperature affects diseases and insects. In addition, to help you decide if there is a benefit for your business we will present real numbers on how much you save on heating costs versus how much you lose through increased crop production time when you drop temperatures. Lastly, we review some quick and inexpensive ways to help reduce your heating costs.

PLANT DISEASES

One very important consideration when producing plants under cool temperatures is the potential for increased disease pressure. This is the result of three things: 1) Some diseases are more active at cool temperatures; 2) plants, benches and floors stay wet longer after each watering when temperatures are lower, providing a larger window for pathogen spores to germinate (spore germination of many fungi requires moist conditions); and 3) plant health of some species is weakened (optimal plant growth usually occurs at temperatures around 68º F).

Diseases caused by Pythium, Rhizoctonia and Thielaviopsis are promoted under cool temperatures; spore germination and proliferation of water molds require moist conditions. For instance, "damping off" is most severe at 53-68º F. Damping off diseases are not the only diseases promoted by cool temperatures. Thielaviopsis is the pathogen that causes black root rot and, unfortunately, is becoming a more common problem for pre-finished plants, particularly pansies, vinca and petunias. Thielaviopsis can be a problem under cool or warm temperatures, but Thielaviopsis activity is reported to be optimal at 62º F. Another widespread disease promoted by cool temperatures is gray mold caused by Botrytis. Botrytis is often a problem during shipping, when weather conditions are cloudy in spring and/or when crops grow together in a greenhouse, restricting air movement around plants. Previous research identified 71º F as optimal for Botrytis growth and 59º F as optimal for Botrytis spore production.

When plants are grown cool, they require less water than when they are grown warmer. In addition, when you grow cooler, media will stay wet longer because standing water will take longer to evaporate off the media surface. Combined, these two factors can increase the root rot disease pressure on plants grown under cool conditions if water management is not altered as well. It is very important to actively scout for diseases and have a plan ready for applying fungicides before the need arises.

Here are some suggestions from Steve Nameth, The Ohio State University, for reducing disease severity when growing under cool temperatures:

• Don't place seed flats/seedlings on the floor. Floor temperature can be 10-20º F cooler than the air temperature a few feet off the ground; also, having flats on the floor increases the amount of time that free standing water is present, creating germination opportunities for fungal spores. Raising flats off of the floor even a few inches will raise the temperature and reduce direct contact with standing water.

• Keep floors and benches as dry as possible. As mentioned previously, if water management, even on floors and benches, is not altered root rots are more likely.

• Keep air circulating. Keeping air moving at all levels of the greenhouse, not just at bench level, will reduce the length of time you have standing water after each watering.

• Use active bottom heating if possible. Heating of seed trays to the appropriate temperature will reduce disease severity by promoting actively growing plants and raising the temperature above the optimum for damping off disease growth. If you do not already have heating pads, etc., they are expensive to install. However, you may want to consider ➧

Quick Tips

Here are some tips for reducing your energy bill in both the short and long term:

* Install energy curtains
* Reduce air leakage
* Provide heat only where it is needed, i.e., under benches and around plants
* Circulate air to reduce/eliminate cold spots
* Install energy efficient heating system
* Calibrate temperature sensors
* Insulate greenhouse perimeter
* Use a double-layer glazing material
* Install windbreaks
* Use the cheapest fuel available
* Skirt benches to localize heat around plants

installing them as a long-term strategy to reduce heating costs.

Keep in mind that fungicide chemical activity can be reduced at lower temperatures. Therefore, it may take longer to see results of an insecticide/fungicide application, and/or an application may be less effective. Do not increase the amount of chemical applied because you do not see an effect as soon as you would expect.

INSECT CONTROL

Since insects are not warm-blooded, temperature is the greatest factor when determining the development rate of insects. Cool temperatures slow the life cycle of insects (Figure 1, right). For example, decreasing temperature from 80º F to 55º F increases fungus gnat life cycle time (from egg to adult) from 12 to 27 days. Similarly, decreasing temperature from 86º F to 68º F increases western flower thrips life cycle time from 16 to 31 days. Therefore, you may be able to increase the time in between pesticide applications to maintain the same number of applications during a single life cycle. Bottom line is that dropping temperatures will slow insect or pest proliferation in your greenhouse.

SAVING MONEY

Reducing temperature usually slows crop development. In addition, keep in mind that you may also be decreasing the total number of crops you can turn through your greenhouse within a given amount of time. If you are strictly a spring bedding plant grower or you are dependent on producing a certain number of crops (or turns) each season, decreasing greenhouse temperature may not save you money. It is important to compare the total fuel cost of producing a crop under the temperature you would traditionally use with the lower per-day costs but with increased production time of a cooler temperature regime. Here are some examples of calculating the impact of reduced temperatures on costs associated with some crops.

Let's use 'Purple Wave' petunia as an example to illustrate how reducing temperature will impact overall fuel usage during the entire production time of a crop. From an equation in Part I of this series (see *GPN* September 2004) we can predict that Purple Wave will flower in 64 days at 68º F. For this example, let's assume that you want to reduce temperature from constant 68º F to a 68º F day and 58º F night temperature regime (using 12 hours at each temperature). This results in an average daily temperature of 63º F. We know that Purple Wave petunias will flower in 80 days when grown at 63º F.

Using information from the Natural Resource, Agriculture, and Engineering Service bulletin *Greenhouse Engineering*, we can compare the approximate total fuel usage for growing Purple Wave under a day/night temperature

Figure 1. Impact of temperature on life cycle duration of common greenhouse insect pests.

INSECT	IMPACT OF TEMPERATURE ON TIME FROM EGG TO ADULT
Aphid (Green Peach)*	Increases from 6 to 20 days as temperature decreases from 68 to 50° F.
Aphid (Cotton/Melon)*	Increases from 7 to 10 days as temperature decreases from 77 to 68° F.
Fungus Gnats	Increases from 12 to 27 days as temperature decreases from 80 to 55° F.
Shore Flies	Increases from 10 to 16 days as temperature decreases from 93 to 73° F.
Spider Mite (Two Spotted)	Variable, but generally increases from 8 to 28 days as temperature decreases from 86 to 59° F.
Thrips (Western Flower)	Increases from 7 to 13 days as temperature decreases from 98 to 62° F.
Whitefly (Greenhouse)	Approximately 21–26 days at 81° F and 32–39 days at 65-75° F.
Whitefly (Silverleaf)	Increases from 16 to 31 days as temperature decreases from 86 to 68° F.

**Aphids do not reproduce by eggs. Reported times are from birth to adult.*

regime of 68/68° F or 68/58° F. In Minneapolis, Minn., we need to provide 19.2 heating degree days (HDD; in this case defined as a 24-hour period in which the inside temperature is 1° F higher than the outside temperature) during the night to maintain a 68° F night temperature and 16.3 HDD to maintain a night temperature of 58° F. Therefore, the approximate number of HDD provided at night to grow Purple Wave at constant 68° F is:

19.2 HDD/day X 64 days = 1,229 total HDD

In contrast, growing plants at 68 F/58° F would require approximately:

16.3 HDD/day X 80 days = 1,304 total HDD

Therefore, the total amount of fuel required to produce a Purple Wave crop under the cooler temperature regime is approximately 6 percent higher than growing Purple Wave at constant 68° F. Keep in mind that this is an extreme example. In contrast to Purple Wave, we can predict from previous data that pansy 'Crystal Bowl Supreme Yellow' will flower in 53 days at 68° F and 59 days at 63° F. Therefore, the approximate number of HDD needed to grow pansy Crystal Bowl Supreme Yellow at 68° F is:

19.2 HDD/day X 53 days = 1,018 total HDD

While growing plants at 68/58° F would require approximately:

16.3 HDD/day X 59 days = 962 total HDD

In the above example, growing pansy Crystal Bowl Supreme Yellow under the cooler temperature regime resulted in a fuel savings of approximately 5.5 percent. It is important to consider that increasing crop production time with a cool temperature regime may eliminate any fuel savings you gain by increasing other costs with some crops, but economical with other crops.

The best thing to do is separate plant species based on "warm temperature loving" versus "cold temperature loving" and dropping temperature on only cold temperature-loving crops. We already do this to some degree when we grow pansies cool. However, some crops like Purple Wave petunia, melampodium, portulaca, cleome and vinca are warm temperature loving and should not be grown cool, as crop production time will be greatly increased. In contrast, viola, pansy, alyssum and nemesia are examples of cool temperature-tolerant crops in which crop time will not be greatly increased by growing cooler.

HEAT LOSS COSTS

Different greenhouse glazing materials lose heat at different rates. Single-layer glass and single-layer plastic film lose heat at the highest rates. In comparison, double-layer polycarbonate, or acrylic, loses heat at less than half the rate of single-layer glass or plastic.

Installing a thermal energy blanket can greatly reduce fuel usage for two reasons. First, adding the energy blanket reduces the rate of heat loss from the greenhouse. For example, adding a thermal energy blanket to a greenhouse covered with single-layer glass reduces the heat loss rate by a half, the same rate as you would have with double-layer acrylic over your entire greenhouse. Second, energy blankets reduce fuel costs by reducing the volume of air you are heating. Why spend money to heat the roof of your greenhouse when your plants are 10-20 ft. below? The short-term cost of installing energy blankets can quickly be recovered by reducing fuel costs.

The current energy crisis is not likely to go away any time soon. Therefore, optimizing greenhouse heating efficiency should be a priority for any greenhouse expansion plans. You have less flexibility in altering your current structures to increase energy efficiency. It is often said that growing plants is as much an art as it is a science. This will certainly be very true as growers search for creative ways to reduce energy costs without sacrificing plant quality and, ultimately, profitability. GPN

John Erwin is associate professor and Charlie Rohwer and Ryan Warner are graduate research assistants at the Department of Horticultural Science at the University of Minnesota. They can be reached by phone at (612) 624-9703 or E-mail erwin001@maroon.tc.umn.edu.

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