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Tips for Holding Greenhouse Crops during COVID-19 Restrictions

Many greenhouse producers and retailers are having to hold onto spring crops longer than anticipated because of changes to shipping logistics and stay-at-home orders in place for COVID-19, the infectious disease caused by the novel coronavirus. In this article, we summarize some options to hold plants and avoid discarding your crops.

First, use environmental controls to slow down growth and development. If this is not possible, then a second option is using plant growth retardant (PGR) applications covered in [e-GRO Alert 9.20](#). A third option is to move cold-tolerant crops outdoors, and fourth, cut back your crop. As a last resort, cut your losses and discard plants. By using low temperature versus high rates of PGRs or trimming, one can quickly turn around a plant for sale without affecting consumer experience. High rates of PGRs can last excessively long, especially when applied as a substrate drench, resulting in poor consumer performance.

Figure 1. Cold-tolerant petunia held outdoors to make space for other crops in the greenhouse.



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Let's review how the average daily temperature (ADT) and the Difference between the day and night temperature (DIF) influence plant development and extension growth. Plants integrate temperature over time and lowering the temperature slows down development. Therefore, a crop grown at a day/night (12 h/12 h) temperature of 65/55 °F (18/13 °C) would flower at the same time as a crop grown at a constant 60 °F (15.5 °C) or a day/night of 55/65 °F (13/18 °C) because the ADT is the same. DIF is the difference between day and night temperatures, in other words, the day temperature minus the night temperature. A night temperature that is warmer than the day temperature is a negative DIF, which inhibits stem elongation in many crops. In contrast, a warmer day than night (positive DIF) promotes stem and leaf elongation.

Each species has a specific minimum, optimum, and maximum temperature that influences their development rate. As you lower the temperature in the greenhouse, plants develop progressively slower. At some species-specific temperature, development stops, and this low temperature is referred to as the base temperature (T_b). The T_b can vary among species and even cultivars, and is estimated to range from roughly 30 to 54 °F (-1 to 12 °C) for the floriculture crops that have been investigated at Michigan State University (Table 1). For example, the T_b of viola is ≈ 39 °F (3.9 °C), which means that at or below this temperature, a viola crop will stop growing. In contrast, vinca (*Catharanthus*) has a higher T_b of ≈ 53 °F (12 °C). Not surprisingly, many growers find that vinca develops very slowly when grown in the same greenhouse as a viola crop if the temperature set point is cool, such as 60 °F (16 °C).



Figure 2. This grower is covering his crop with a frost cover because the temperature is forecast to reach 32 °F.



Figure 3. This southern grower is growing cold-tolerant and cold-intermediate crops outdoors and has frost cover on hand in case it is needed.



Figure 4. Sprinkling water on crops before a frost can prevent them from freezing.



Figure 5. Sprinkling water on crops before a frost can prevent them from freezing.



Figure 6. Once the ice melted, plants had no visible signs of injury.

Therefore, we can use the T_b of crops to inform us of what temperatures to use to hold crops and to help select plants to move outdoors should outdoor space be available. In Table 1, crops have been categorized into three different temperature-response categories:

Cold-tolerant crops

- Cold-tolerant crops have base temperature of 39 °F (4 °C) or lower.

You will need to deliver a relatively low greenhouse ADT to hold crops in this category. For these crops, effective hold temperatures are as low as 45 to 50 °F (7 to 10 °C). For example, if you are growing at an ADT of 65 °F (18 °C), lower the ADT to 50 to 55 °F (10 to 13 °C) by lowering both the day and night temperature set points. If you can create a negative DIF (provide a cooler day than night temperature), this will help with controlling elongation.

Additionally, if you have the outdoor space, you can move some cold-tolerant plants outdoors because many can tolerate a light frost (Figure 1). Acclimate these plants to progressively cooler temperatures before moving them outdoors, if time allows. Do not move plants outside from a warm greenhouse if the forecast is for frost or freezing temperatures for the following three or four days. Cool, but non-freezing or frost temperatures help acclimate the plants to tolerate a frost.

Argyranthemum, bidens, calibrachoa, pansy, some petunia cultivars, and snapdragon can be moved outside first, since they are among the most tolerant of temperatures as low as 25 to 32 °F with some protection. Although both African and French marigold are cold-tolerant crops, they will not withstand freezing temperatures. When the chance of temperatures dipping below freezing are much less likely, dianthus, diascia, nemesia, and osteospermum can be moved outdoors. There is certainly risk though, because some series and cultivars are more temperature sensitive than others, and a hard freeze can kill or damage plants. However, this strategy can help buy time and open up precious

greenhouse space. To learn more about our previous research on growing cold-tolerant crops outdoors and in high tunnels read [this article](#).

Cold-temperate crops

- Cold-temperate crops have a base temperature between 40 to 45 °F (4 to 7 °C). These crops can have a higher “hold” temperature because they have a higher T_b than cold-tolerant crops. Effective hold temperatures are as low as 50 to 55 °F (10 to 12 °C) Only a few cold-temperate crops can be moved outdoors once temperatures are not likely to reach below around 37 °F (3 °C). This includes bracteantha, lobelia, stock, and verbenas.

Cold-sensitive crops

- Cold-sensitive crops have a base temperature of 46 °F (8 °C) or higher. These crops have the highest base temperatures and thus, the highest hold temperatures, with minimums of 55 to 60 °F (13 to 16 °C). Going back to our vinca example, if we lower the ADT to 60 °F, rooting and development is very slow, but the risk of diseases such as *Pythium* and *Thielaviopsis* increases, partly because plants dry so slowly. These crops should only be considered for moving outdoors as a last resort unless frost or freezing temperatures are past and the ADT are above 50 °F (10 °C).

Methods to protect crops

If temperatures are forecast to dip below about 37 °F (3 °C) and the night is clear with no wind, expect a radiant frost. Any time a radiant frost or freezing temperatures are forecast, move plants to a protected area or cover them with a lightweight Reemay cloth, floating row, or frost cover (Figures 2 and 3).

them from freezing because liquid water releases heat as it freezes and prevents the plant temperature from dropping below freezing. Start sprinkling when the air temperature is 36 °F (3 °C) on clear nights or better, use an infrared (IR) thermometer and start sprinkling when the lowest observed leaf or flower temperature is 32 °F (0 °C). The plants in Figures 4 and 5 survived temperatures in the low 20's °F (-5 °C) for several hours without damage and were fine once the ice melted (Fig. 6).

Cut/mow/trim plants

Growers can manually cut plants back, or use a trimming machine (Figure 7). Manual pruning requires a lot of labor, but cutting plants back can decrease the amount of space plants will subsequently occupy, or more importantly, allow fresh growth for later sale. Time to re-flower depends on the crop and growing conditions, and may be as little as two weeks. Most annual bedding plants will re-flower after trimming. In contrast, many early-season herbaceous perennials in flower may not re-flower.

If you trim plants, do your best to remove all cut-off material (leaves, stems, and flowers). Any plant debris left is subject to *Botrytis*. Here is a recent MSU article on [management of botrytis using fungicides](#).

Throw plants away

No one ever wants to dump plants, but if you have plugs and liners ready to be transplanted, and your greenhouse is full, consider discarding ripe plants that have little or no chance of selling. It can be better to cut your losses now, so that space becomes available for new plant material scheduled for a later market.

As a general rule of thumb, if considering plants to move outdoors, consider plants in the cold tolerant category in the table below (other than marigold) first, then cold-temperate species, and finally cold-sensitive species last.

Table. 1. Estimated base temperature (T_b) of floriculture crops from research conducted at Michigan State University. Crops were categorized into the following three temperature response categories based on their T_b : cold-tolerant, -temperate and -sensitive.

¹For more specific information, visit <https://www.canr.msu.edu/floriculture/resources/annuals>

Cold-Tolerant ¹ (Low T_b) <39 °F (4 °C)	Cold-Temperate (Moderate T_b) 40 to 45 °F (4 to 7 °C)	Cold-Sensitive (High T_b) >46 °F (7 °C)
Argyranthemum	Bracteantha	Ageratum
Alyssum	Calibrachoa	Angelonia
Bidens	Calendula	Blue salvia
Dianthus	Cosmos	Browallia
Diascia	Cupflower	Celosia
America marigold	Dahlia	Gerbera
French marigold	Gazania	Globe amaranth
Nemesia	Geranium	Pentas
Osteospermum	Flowering tobacco	Portulaca
Petunia (Bravo, Dreams and Easy Wave)	Impatiens (seed)	Torenia
Snapdragon (Liberty Classic and Montego)	Lobelia	Vinca
Stock	Petunia (Shock and Wave Purple Classic)	Zinnia
Viola	Rudbeckia	
	Verbena	
	Wax begonia	



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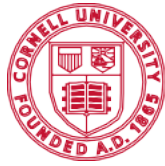
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