*By Erik Runkle*

MICHIGAN STATE UNIVERSITY EXTENSION
FLORICULTURE TEAM

# Holding Plugs and Liners

This year, many regions of the country had a very wet spring. Consequently, demand for garden plants was delayed, which prevented some producers from shipping crops as scheduled. Growers had to therefore hold their crops longer than anticipated, making less space available for the next greenhouse crop. Some growers who had purchased or grown young plants for the next crop faced a difficult decision: to continue to hold the marketable finished plants in hopes they could ship them soon and delay or not transplant their young plants or to dump the finish plants so that greenhouse space was available for the next crop.

Most plugs and liners can be held in the greenhouse for a short time (e.g., seven to 10 days) with little or no negative effect on subsequent growth. However, the plants still require space, light, water, etc. Especially at warm temperatures, young plants continue to grow and can quickly become overgrown. Overgrown plugs typically have elongated and thin stems, poor branching, and in some cases they may not root as well after transplant.

If plugs and liners cannot be transplanted within a short period of time, they are best held at a low temperature. In the early 1990s, a floriculture team at Michigan State University, led by Royal Heins and Will Carlson, determined desirable cold storage temperatures and maximum holding durations for a range of seedling plugs (Table 1). An electronic copy of their 18-page booklet, which contains a substantial amount of research-based information, is available online at http://flor.hrt.msu.edu/production-info (see "Cold Storage of Plug Seedlings").

Not surprisingly, cold-tolerant crops such as alyssum, pansy and petunia stored best at temperatures just above freezing (36° F). Higher storage temperatures were needed for cold-sensitive plants such as celosia and vinca (50° F) and New Guinea impatiens (55° F); at lower temperatures, plants developed chilling injury. Nearly all plants could be stored for at least three weeks at the suggested temperatures when provided with low-intensity light (at least 1 $\mu mol \cdot m^{-2} \cdot s^{-1}$, or 5 foot-candles). With the exception of fibrous begonia, dahlia and French marigold, plants with an optimum storage temperature of 45° F or less tolerated darkness equally well. In contrast, the cold-sensitive crops tolerated storage one week longer when provided with light.

Although not specifically tested, one can infer desirable storage temperatures of additional garden plants based on their estimated base temperatures (see the January 2011 issue of *GPN*). For example, storage temperatures of 36 to 41° F would be appropriate for osteospermum, snapdragon and viola whereas 50 to 55° F is suggested for angelonia, blue salvia, pentas and zinnia.

Crops with the lowest suggested storage temperatures should probably be given priority for storage because they grow relatively quickly at warm greenhouse temperatures. Crops can also be grouped into broader storage temperature categories. For example, 41° F could be used for plants with suggested storage temperatures of 36 and 41° F. Many growers don't have refrigerated space, but building a small chamber (or renting a refrigerated truck) can be a worthwhile investment given the value of young plants.

At the onset of storage, ensure the young plants are well watered but have dry foliage. Plants must also be free of diseases, especially Botrytis. A fungicidal spray before storage may be prudent. In storage, protect plants from direct air flow from the heat exchanger, as this will dry out the plants quickly. Although growth slows during storage, it doesn't stop and thus, plants require continued care. Finally, there is likely variability among cultivars in tolerance to storage temperatures and durations. Keep a close eye on plants, and remove them from storage if there are initial signs of chilling damage. g

***Erik Runkle is associate professor and floriculture extension specialist in Michigan State University's department of horticulture. He can be reached at runkleer@msu.edu or 517.355.5191 ext. 1350.***

**Table 1. Suggested temperatures and maximum durations for storing young plants held in darkness or under low-intensity light. From Heins, Lang, Wallace, and Carlson, 1994.**

| Species | Temperature (°F) | Maximum duration (weeks) in dark/light |
|---|---|---|
| Alyssum | 36 | 5/6 |
| Cyclamen | 36 | 6/6 |
| Geranium | 36 | 4/4 |
| Pansy | 36 | 6/6 |
| Petunia | 36 | 6/6 |
| Begonia, fibrous | 41 | 6/6 |
| Begonia, tuberous | 41 | 3/6 |
| Dahlia | 41 | 2/5 |
| Lobelia | 41 | 6/6 |
| Marigold, French | 41 | 3/6 |
| Salvia | 41 | 6/6 |
| Ageratum | 45 | 6/6 |
| Impatiens | 45 | 6/6 |
| Portulaca | 45 | 5/5 |
| Tomato | 45 | 3/3 |
| Verbena | 45 | 1/1 |
| Celosia | 50 | 2/3 |
| Vinca | 50 | 5/6 |
| New Guinea impatiens | 55 | 2/3 |