

# Another Look At Storing Plugs

**This month:  
petunias and  
geraniums**

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**U**SING low temperatures to “hold” plugs or slow their growth until you’re ready to transplant them is an alternative to using water and nutrient stress or growth regulator applications. These traditional methods stress the plugs and have the potential to slow and delay plant growth after transplanting.

The objective of our research was to determine how long plugs could be stored satisfactorily under different temperature and light combinations without adversely affecting

growth and forcing time after transplanting.

This article discusses results from storage experiments on petunia and geranium plugs.

### How We Did It

Twenty-five plug sheets (size 406) of ‘Ultimate Red’ petunia were obtained from a commercial grower when plants were at a transplantable stage (Figure 1).

The plants were held in a glass greenhouse at 68°F for 1 week prior to the start of the storage treatments

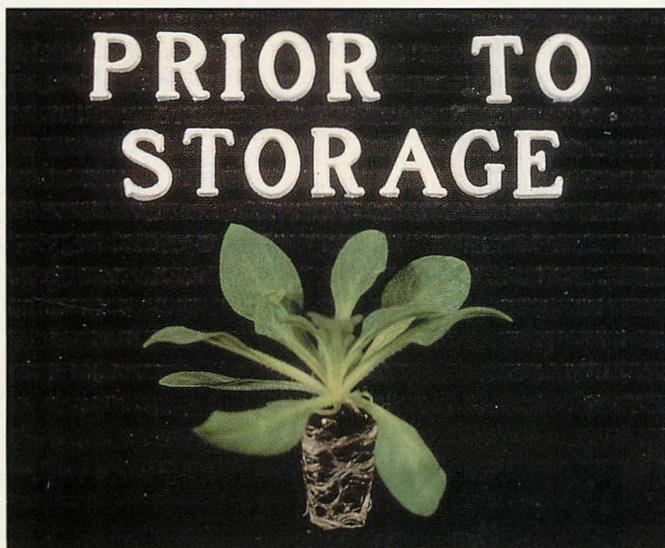


Figure 1. Petunia.

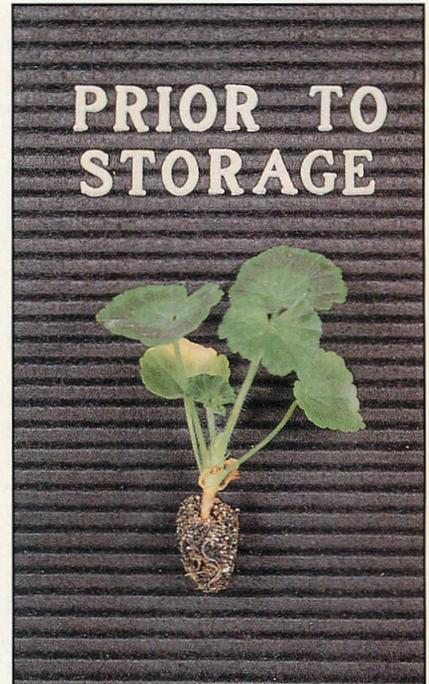


Figure 2. Geranium.

### Last Month's Highlights

Last month in *GREENHOUSE GROWER* (page 22), we discussed the potential for storage of bedding plant plugs, specifically pansy and impatiens plugs. Results of our experiments showed that:

- Impatiens plugs stored satisfactorily in the dark for 6 weeks at 45.5°F.
- A storage temperature of 32°F caused impatiens death and storage temperatures of 36.5°F and 41°F caused unacceptable chilling injury and plant death after 2 and 3 weeks of storage, respectively.
- Pansy plugs satisfactorily tolerated 16 weeks of storage in the dark at 32° and 36.5°F and up to 6 weeks at 50°F.

to remove any possible effects of shipping.

On March 14, 1990, one plug sheet was placed at each of 24 different temperature and light level combinations. Temperatures were 32°, 36.5°, 41°, 45.5°, 50° and 54.5°F.

Light levels were 0, 5, 25, and 50 footcandles. Light levels were provided by cool white fluorescent bulbs with a photoperiod of 24 hours per day. Darkness (or 0 footcandles) was provided by placing a plug sheet in a closed cardboard plug shipping box.

Ten representative plants were removed from each plug sheet of each temperature/light treatment after 1, 2, 3, 4, 5, and 6 weeks.

A representative plant from each treatment was used for a photograph and all plants were then potted in 4-inch pots using a commercial soilless mix. The plants were forced into flower in a glass greenhouse with a minimum temperature of 68°F.

We recorded the date of first flower

for each plant surviving storage. We also determined the average number of days from the start of forcing until first flower and the percentage of plant survival for each treatment.

We then rated the storage treatments as satisfactory or unsatisfactory. Satisfactory storage treatments had no more than 1 out of 10 plants die following storage and plants did

not show a delay in flowering of more than 5 days compared to control plants, which were potted directly without any storage.

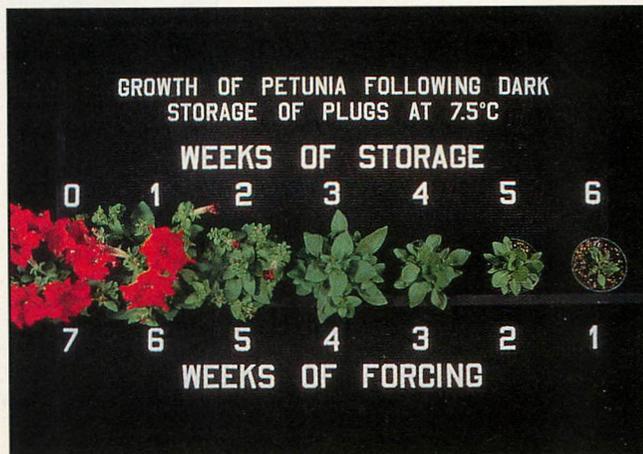
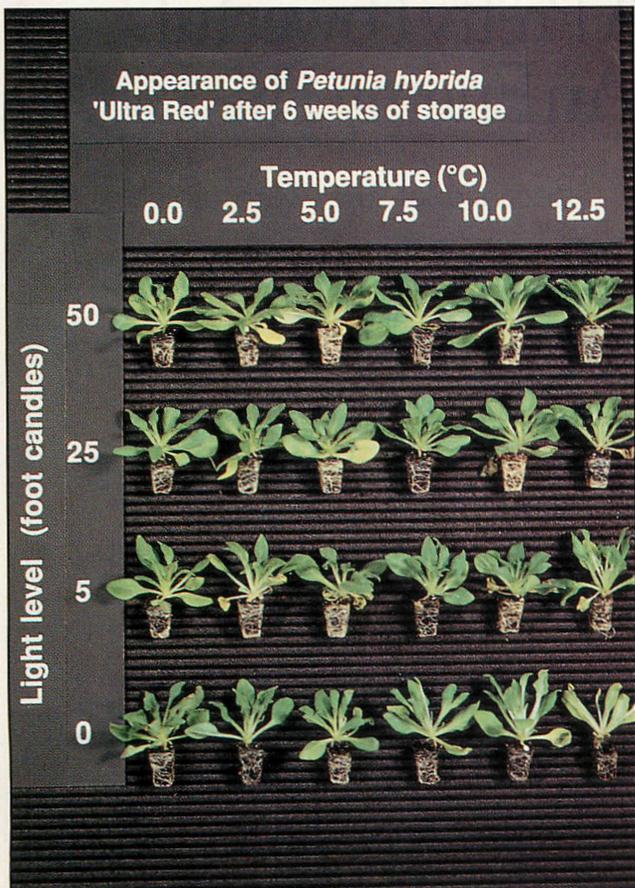
'Pinto Red' geranium plugs (see Figure 2) were treated in the same manner as the petunia plugs, except the storage treatments started on April 3, 1990.

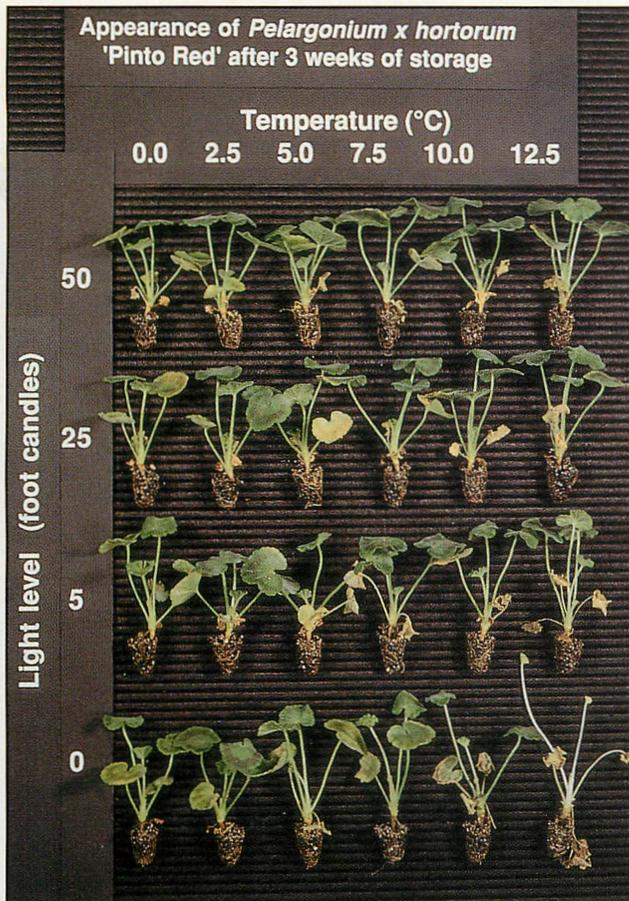
All plugs were subirrigated with

Figure 3 (right). Appearance of petunia plugs immediately after storage for 3 weeks.

Figure 4 (below, left). Petunia plugs after 6 weeks.

Figure 5 (below, right). Growth of petunia plugs after storage of 0-6 weeks at 45.5°F in the dark and 6-0 weeks of greenhouse forcing, respectively.





clear water as needed during storage. We used clear water because the plants' nutritional requirements are minimal at low temperatures.

The frequency of irrigations varied from 2 to 10 days, depending on the temperature treatment and humidity of each cooler. Contact between the foliage and water was minimized to avoid any possible fungal infection.

### Reviewing the Results

Geranium and petunia plugs responded similarly to storage temperature. Both species tolerated freezing temperature (32°F) and deteriorated at warmer temperatures.

Petunia plugs stored satisfactorily for 6 weeks at temperatures ranging from 32° to 41°F in the darkness (Table 1). The addition of 5 footcandles light increased the satisfactory temperature for 6 weeks of storage to 54°F.

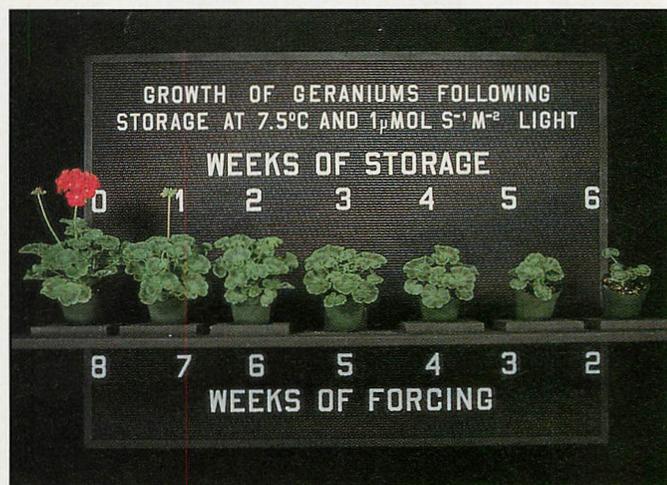
Figures 3 and 4 show the appearance of the petunia plugs at all temperature and light combinations immediately following 3 and 6 weeks of storage.

Figure 5 shows the appearance of

**Figure 6 (above, left).** Geranium plugs after storage for 3 weeks.

**Figure 7 (above, right).** Geranium plugs after storage for 6 weeks.

**Figure 8.** Growth of geranium plugs after storage of 0-6 weeks at 45.5°F in 5 footcandles of light and 6-0 weeks of greenhouse forcing, respectively.



the petunia plants grown from plugs stored at 45.5°F in the dark for 0 to 6 weeks and forced for 6 to 0 weeks, respectively, in the greenhouse.

Flowering data was collected on geraniums up through 4 weeks of storage. A greenhouse cultural problem prevented flowering data from being collected on plants stored for 5 and 6 weeks.

With this limitation, geranium plugs stored satisfactorily for 4 weeks at temperatures from 21° to 50°F in the dark (Table 2). The addition of 5 footcandles light increased the satisfactory temperature for 4 weeks of storage to 54.5°F.

Figures 6 and 7 show the appearance of the geranium plugs at all temperature and light combinations

Table 1. Petunia

| Foot Candles | TEMPERATURE (°F) |      |    |      |    |      |
|--------------|------------------|------|----|------|----|------|
|              | 0                | 36.5 | 41 | 45.5 | 50 | 54.5 |
| 0            | 6                | 6    | 6  | 5    | 5  | 4    |
| 5            | 6                | 6    | 6  | 6    | 6  | 6    |
| 25           | 6                | 6    | 6  | 6    | 6  | 6    |
| 50           | 6                | 6    | 6  | 6    | 6  | 6    |

Table 2. Geranium

| Foot Candles | TEMPERATURE (°F) |      |    |      |    |
|--------------|------------------|------|----|------|----|
|              | 0                | 36.5 | 41 | 45.5 | 50 |
| 0            | 4                | 4    | 4  | 4    | 2  |
| 5            | 4                | 4    | 4  | 4    | 4  |
| 25           | 4                | 4    | 4  | 4    | 4  |
| 50           | 4                | 4    | 4  | 4    | 4  |

Acceptable durations (weeks) of plug storage at different temperature and light combinations in MSU experiments.

immediately following 3 and 6 weeks of storage. Figure 8 shows the appearance of the geranium plants grown from plugs stored at 45.5°F with 5 footcandles of light for 0 to 6 weeks and forced for 6 to 0 weeks in the greenhouse.

### The Optimum Temperatures

While both petunia and geranium plugs stored satisfactorily for at least 4 weeks in the dark over a temperature range of 32° to 50°F, we believe that the optimum temperature for longest storage is near 37.5°F for these two species.

Although both species tolerated freezing temperatures (32°F), we do not recommend storing them at this temperature. The margin of error between storage and freezing is small.

Botrytis was a major problem on both the petunia and geranium plugs, just as with the impatiens discussed last month. We currently recommend that petunia and geranium plugs be stored under low humidity conditions to prevent Botrytis.

Irrigation will likely be necessary if plugs are stored longer than 1 week under low humidity conditions.

### Moving To Warm Greenhouse Conditions

Moving plug seedlings from a cool storage environment to a warm, high

light greenhouse has not been a problem for us if the plugs were moist when they were moved.

In one trial set up to simulate extreme conditions, we placed pansy seedlings that had been stored for 3 weeks at 36.5°F directly into a sunny glass greenhouse where the temperature was set at 100°F.

There was some leaf damage on the seedlings at the edge of the plug sheet; they wilted rapidly. We believe that they were dry when placed in the greenhouse. Seedlings in moist plugs did not wilt and showed no damage.

We suggest warming plugs for a few hours in a low light, moderate temperature (60°-70°F) environment after storage. Irrigate them if they are to be placed into an especially bright, hot environment.

### One More Management Tool

The results from these experiments suggest that there is great potential for storing bedding plant plugs in coolers instead of holding them in the greenhouse.

Plug storage could be used as any other management tool to help your plug production operation be more successful.

### Cool Plugs Before Shipping

Our results also show that cooling plugs prior to shipping will improve

their postharvest condition when they reach their final destination.

We have heard of situations where pansy plugs have been shipped from northern states to southern states and arrived with elongated petioles.

Based on our observations of the length of time pansies can be held under low temperatures with no petiole elongation, plants arriving with elongated petioles must have been shipped at temperatures above 50°F.

Removing field heat by cooling is a common practice after harvest in fruit and vegetable crops to prevent loss of quality during shipping. Likewise, cooling the plug soil and seedling to remove greenhouse heat will help prevent loss of bedding plant plug quality during shipping.

### A Few Words Of Warning

The impact of storage on plugs may vary depending on the specific storage conditions, age, species, cultivar, and physiological state of the plugs. There is also evidence that the environmental conditions before and after storage may have an influence on the growth of the plugs following storage.

We believe storage of plugs has the potential to become a viable grower management tool. However, as with anything new, try experimenting with plug storage before you commit large quantities of plug sheets into storage.

Keep in mind that differences in acceptable temperatures exist between different plant species. Remember, for instance, that pansies, geraniums, and petunias can tolerate lower temperatures than impatiens.

Storage trials will be conducted on ageratum, salvia, begonia, and marigold this spring.

The efficacy of several fungicides labeled for Botrytis control will also be evaluated under several storage humidity conditions. **GG**

**About the authors:** Nathan Lange is a master's degree candidate and Drs. Royal Heins and Will Carlson are professors, Department of Horticulture, Michigan State University, East Lansing, MI 48824. This research was funded in part by the Western Michigan Bedding Plant Association, the Fred C. Gloeckner Foundation, and the American Floral Endowment. Petunia plugs were supplied by Mid-American Growers, Grandville, IL, and geranium plugs by Glass Corner Greenhouses, Grand Rapids, MI.