

How To Store Begonia And Marigold Plugs

by ROYAL HEINS and NATHAN LANGE

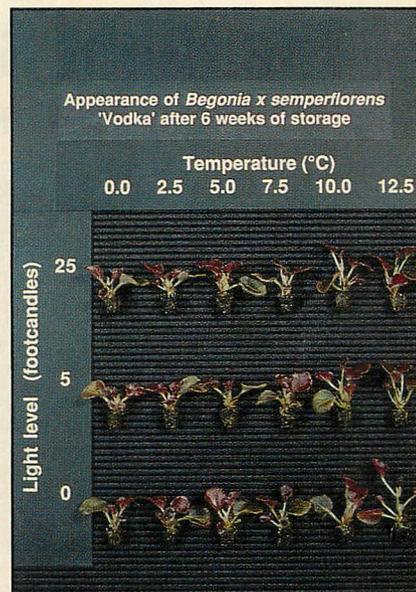
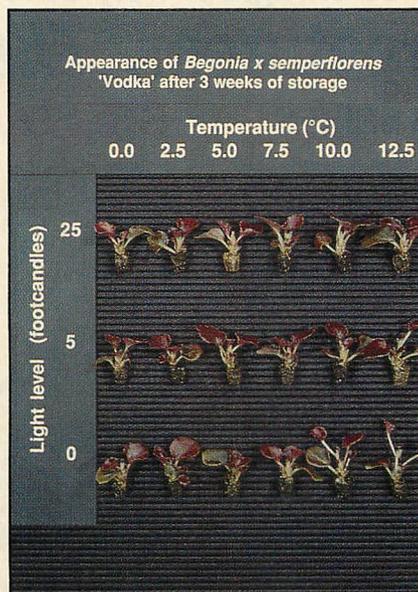
WE have reported results of our experiments in plug storage on petunias, pansies, geraniums, salvias, ageratum, and impatiens in a series of articles (see GREENHOUSE GROWER, January 1991 and February 1991 and 1992).

Those experiments were conducted to determine the length of time plugs could be stored without affecting plant growth, and to determine the optimum storage temperatures for each crop.

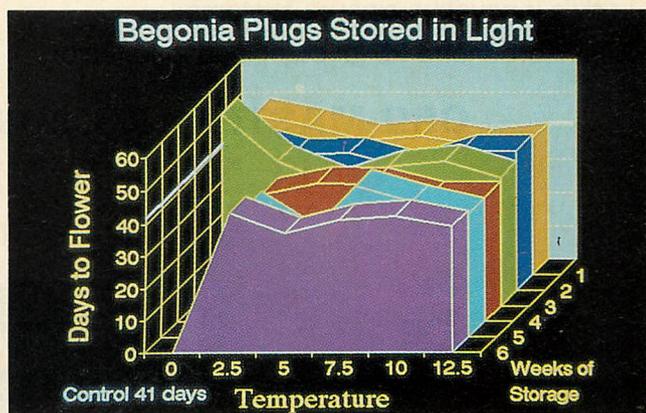
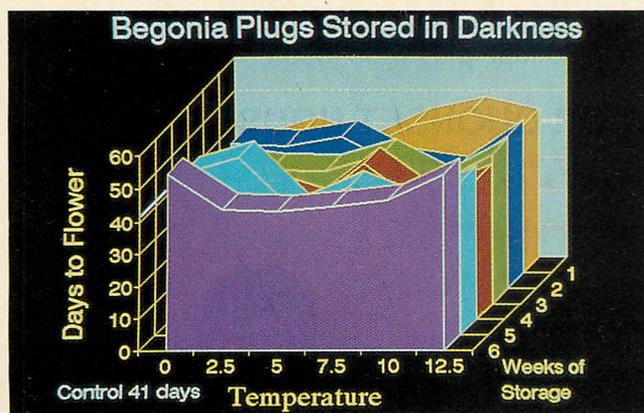
This month, we examine the results of storage experiments on begonias and marigolds.

How We Did It

We obtained 406 plug sheets of 'Vodka' fibrous begonia and 'Hero Yellow' French marigold from a



Figures 1 and 2: Appearance of begonia plugs following 3 weeks' storage (left) and 6 weeks' storage (right).



Figures 3 and 4: Days to flower from transplanting of begonia after 0-6 weeks of dark storage (left) and light storage (right) at 0°-12.5°C (32°-54.5°F).

commercial grower when the plugs reached a transplantable size. They were held in a glass greenhouse at 68°F for 1 week prior to the start of storage treatments to eliminate any possible shipping effects. One plug sheet was placed in storage 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, and 25 footcandles and were generated by cool white fluorescent bulbs 24 hours per day. We obtained 0 footcandles (or total darkness) by placing plug sheets in a closed, cardboard plug-shipping box.

All plugs were subirrigated with clear water as needed during storage. The frequency of irrigation varied from 3 to 20 days, depending on the temperature and humidity of each cooler. To avoid possible fungal infection, we kept the contact between foliage and water to a minimum.

Ten representative plants were removed from each temperature/light treatment after 1, 2, 3, 4, 5, and 6 weeks and a typical plant from each treatment was photographed. All the plants were then potted in 4-inch pots

and forced into flower in a glass greenhouse with a minimum temperature of 68°F.

We recorded the date of first flower and determined the average number of days from the start of forcing until first flower for each plant that survived storage. The percentage of plant survival for each treatment was also determined.

Storage treatments were rated as satisfactory or unsatisfactory. In satisfactory treatments, no more than one out of the 10 representative plants died following storage and transplanting, 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.

Begonia Results

Leaf spotting was evident within a few days on plugs stored at 32°F and to a lesser extent on plugs stored at 36.5°F (Figures 1 and 2). Long-term effects of chilling injury were first manifested by delayed flowering (Figures 3 and 4) and, as storage continued, plant death (Figures 5 and 6).

Flowering delay was more pro-

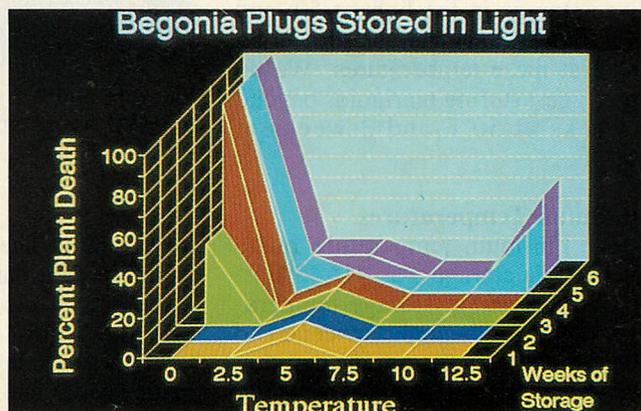
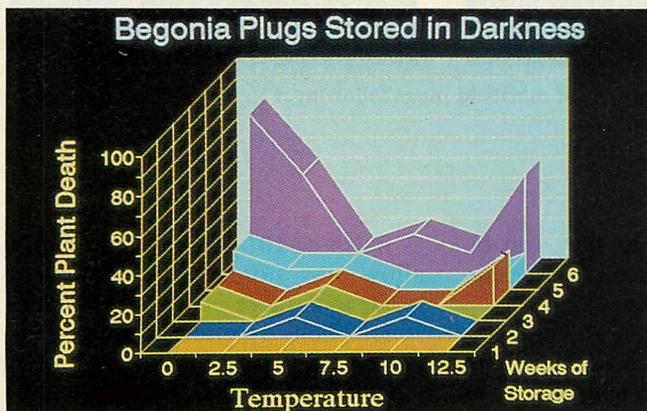
nounced at 32°F. The percentage of dead plants increased when plugs were stored in the light rather than the dark.

While the effects were not as severe at 36.5°F, flowering delay and the percentage of dead plants became progressively greater as plugs were stored for longer time periods.

Begonia seedlings elongated when held at 50° and 54.5°F. Elongation was greater on plugs held in the dark; this elongation was not entirely prevented by storage in the light (Figures 1 and 2). Flowering was significantly delayed on plants stored in the dark at 54.5°F for any duration.

Begonias tolerated storage in the dark for 4 weeks at 36.5°F, 6 weeks at 41°F, and 5 weeks at 45°-50°F when judged by time to flower and percentage of plants surviving (Figure 7). Temperatures of 32° and 54.5°F were unacceptable for dark storage.

The duration of acceptable storage was 6 weeks at 36.5°-50°F when as little as 5 footcandles of light were added to the plants during storage (Figure 7). Even with the addition of 5 and 25 footcandles of light, the ac-



Figures 5 and 6: Percent plant death of begonia after 0-6 weeks of dark storage (left) and light storage (right) at 0°-12.5°C (32°-54.5°F).

ceptable storage duration was limited to 4 and 5 weeks at 54.5°F.

Marigold Results

Temperatures of 32° and 36.5°F caused injury and death in marigold (Figures 8 and 9). As was typical for salvia, ageratum, and begonia, delayed flowering was the first manifestation of chilling injury (Figures 10 and 11). As storage continued, plants died (Figures 12 and 13).

Marigolds were very susceptible to chilling injury at 32°F, a temperature at which flowering was delayed after only 1 week of storage. Chilling injury was less noticeable at 36.5°F, but all plants were dead after 4 weeks of storage (Figures 12 and 13). Most plants survived at 41°F, but flowering was delayed when the storage duration exceeded 3 weeks.

Marigolds did not store well in the dark as temperatures increased from 45° to 54.5°F (Figure 12). Maximum storage duration was 2 weeks at 50°-54.5°F and 3 weeks at 45°F (Figure 14). The combination of chilling injury at low temperatures (32°-36.5°F) and delayed flowering and death at warmer temperatures (45°-54.5°F) resulted in a short acceptable dark-storage time (maximum of 3 weeks).

The addition of light dramatically improved the quality of stored marigold plugs at temperatures of 41°-45°F (Figures 8 and 9, 12, 13, and 14). All plants died after 6 weeks' storage in the dark at 50° and 54.5°F (Figure 12), while 100% of the plants survived after 6 weeks' storage in the light at the same temperatures (Figure 13).

However, even though plants survived storage in the light at 50° and 54.5°F, there was variable flowering delay at these temperatures. We do not suggest storing marigolds beyond 5 weeks at 50°F and 3 weeks at 54.5°F.

Optimum Temperatures

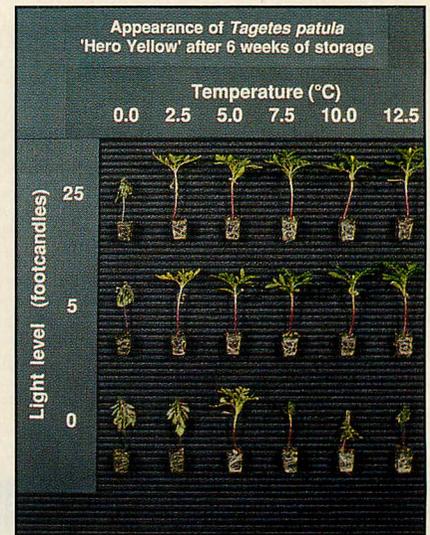
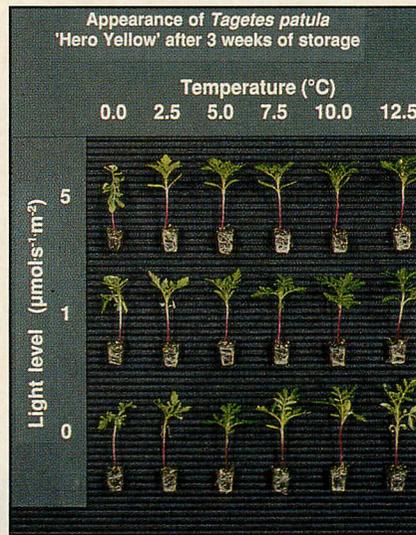
The optimum temperature range for begonia storage was 41°-45°F.

The acceptable storage-temperature range for begonias widened to 36.5°-50°F when the storage duration was 4 weeks or less and when light was added during storage.

The optimum temperature for marigold storage was 41°F. However, even at 41°F, marigolds stored poorly

Figure 7. Storage durations where begonia flowering was not delayed more than 5 days after storage compared to plugs transplanted to the greenhouse without storage. Shaded areas represent storage conditions and durations in which flowering delay was not observed.

Temperature °F	Light footcandles	Weeks of Storage					
		1	2	3	4	5	6
32	0						
	5						
	25						
36.5	0						
	5						
	25						
41	0						
	5						
	25						
45.5	0						
	5						
	25						
50	0						
	5						
	25						
54.5	0						
	5						
	25						



Figures 8 and 9: Appearance of marigold plugs following 3 weeks' storage (left) and 6 weeks' storage (right).

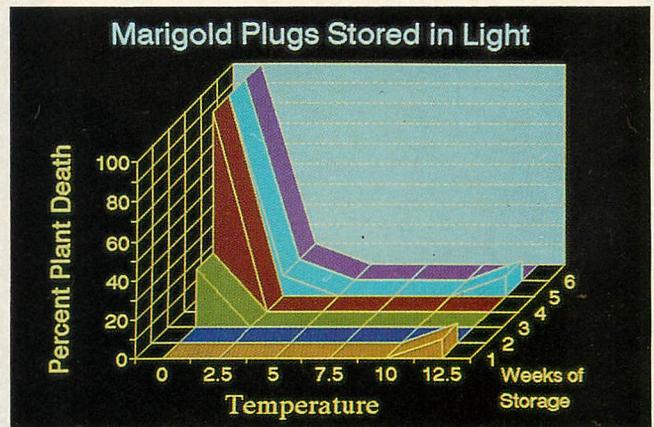
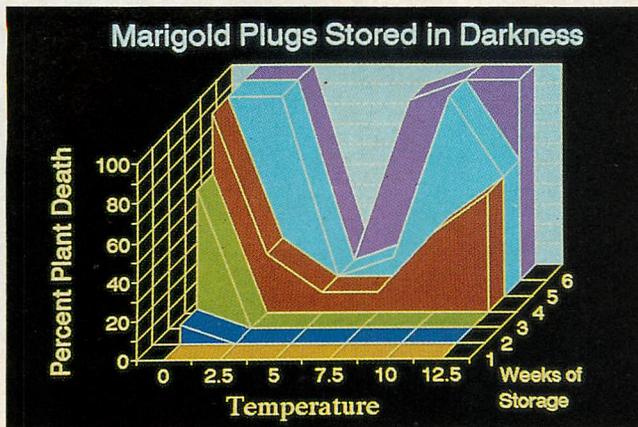
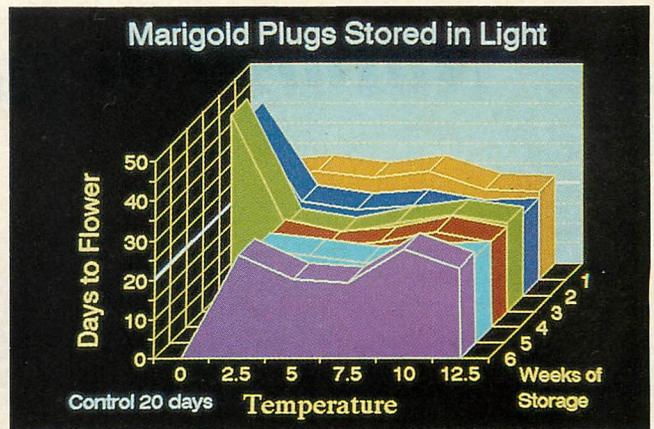
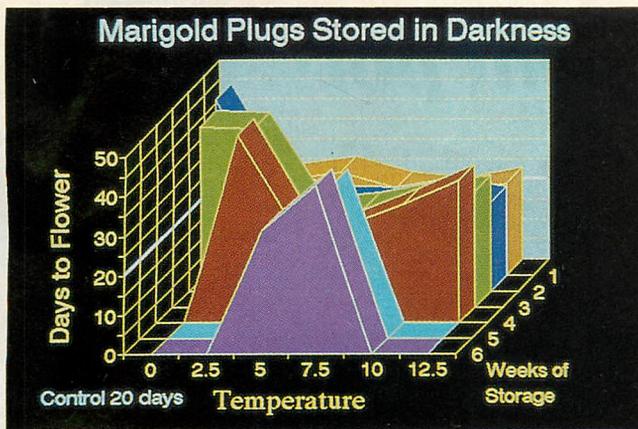
in the dark. The limit they can be stored in total darkness is 3 weeks.

See The Light

Plugs stored better in the light than in the dark, and the addition of as little as 5 footcandles of light increased the temperature range for five of the species (petunia, begonia, marigold, ageratum, and impatiens) by

as much as 10°. Adding light didn't allow plug storage at temperatures lower than those below which dark-stored plants experienced chilling injury.

Petunias tolerated the widest storage-temperature range in the light (32°-54°F), followed by pansies and geraniums (32°-50°F), and begonias and marigolds (36°-54°F). Salvia and



Figures 10 and 11 (top): Days to flower from transplanting of marigold after 0-6 weeks of dark storage (left) and light storage (right). Figures 12 and 13 (bottom): Percent plant death of marigold after 0-6 weeks of dark storage (left) and light storage (right). Temperatures were 0°-12.5°C (32°-54.5°F).

ageratum had a 13° light-storage range (41°-54°F). Impatiens had the narrowest storage-temperature range — only 9° (45°-54°F).

In the dark, petunias, pansies, and geraniums stored well from 32°-50°F. Begonias stored at temperatures ranging from 36°-50°F, while salvia could be kept at 41°-54°F. Marigolds and ageratum had the greatest intolerance to dark storage, performing well only from 41° to 45°F. Impatiens plugs also were intolerant, storing only from 45° to 50°F. **GG**

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Figure 14. Storage durations where marigold flowering was not delayed more than 5 days after storage compared to plugs transplanted to the greenhouse without storage. Shaded areas represent storage conditions and durations in which flowering delay was not observed.

Temperature °F	Light footcandles	Weeks of Storage					
		1	2	3	4	5	6
32	0						
	5						
	25						
36.5	0						
	5						
	25						
41	0						
	5						
	25						
45.5	0						
	5						
	25						
50	0						
	5						
	25						
54.5	0						
	5						
	25						