

Plug Postproduction: Some Helpful Tips

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During the past 20 years, there has been a considerable amount of research on various plug growing issues — nutrition, water quality, media, seed physiology, and growth regulation. It's only been within the last decade that the topic of greenhouse postproduction handling of plugs has been emphasized. During this time, several questions have been asked: How should I tone the plant before shipping? How long can I hold my plugs if I can't ship? What is the effect of temperature on their postproduction life? If I ship in the dark, will the plugs survive?

Early recommendations given to plug growers were to hold the plugs in the greenhouse no longer than necessary. This could be taken as good advice if all growers were operating in an ideal world of commercial production. Unfortunately, growers can't always plant at the correct time, and shippers don't always have a buyer when the plugs are ready to move. This situation has resulted in many trays being dumped and much time and money wasted.

There is also the production time factor that will vary between seasons and between different areas of the United States. We believe that the optimum plug size for transplant has nice root development on the outside of the substrate ball, good root hair development, axillary shoot development, and three to four sets of true leaves. The time to reach this optimum stage will vary depending on environmental conditions. Consequently, the ability to condition and hold plugs before shipping is a great significance to both growers and shippers when these factors are not in line. Understanding the effect of fertilizer rate and formulation, plug size, temperature, and light on both the short-term and long-term postproduction handling of plugs is critical.

Holding Plugs

Early research was aimed at understanding the effects of holding plugs in the greenhouse at 60 to 70 degrees F. Not surprisingly, the results showed that plugs held for several days to several weeks past optimum transplant stage produced poorer quality finished plants with delayed flowering than those transplanted at optimum size. The finished quality was worse the longer the plants were held. Recent research at Texas A&M University has shown similar trends for bedding plants held in various pack sizes. As with plugs, the longer the plants are held past optimum transplant size, the poorer the flowering and overall performance in the landscape.

One of the best ways to hold plugs until they can be shipped is to lower the temperature. A significant amount of research has been done in this area by researchers at Michigan State University. Unfortunately, the optimum storage temperature for plant species differs. Acceptable temperatures for one species may cause chilling injury or even death in another. An important finding from the research was that the addition of light (more than 5 footcandles) increases both the acceptable temperature range and duration time of storage as compared to plants stored in the dark. The light plants generally were of higher quality once they were removed from storage. The following are some guidelines for low-temperature

storage for certain species in either lighted or complete dark conditions.

Petunia. They store satisfactorily for up to five weeks from 32 to 50 degrees F in the dark; in the light, you can store them up to five weeks at 32 to 54 degrees F. This is one of the easier species to hold.

Pansy. They store satisfactorily for up to six weeks from 32 to 50 degrees F in the dark; in the light, you can store them up to 10 weeks at 32 to 50 degrees F. Optimum storage temperature is 32 to 37 degrees F. This is the most cold temperature-tolerant species.

Geranium. They store satisfactorily for up to four weeks from 32 to 45 degrees F in the dark; in the light, you can store them up to four weeks at 32 to 50 degrees F. Optimum storage temperature is 35 to 37 degrees F. This species can be handled like petunia.

Fibrous Begonia. They store satisfactorily for up to four weeks from 37 to 50 degrees F in the dark; in the light, you can store them to six weeks at 37 to 50 degrees F. Optimum storage temperature is 41 to 45 degrees F. Leaf spotting and chilling injury may occur at temperatures less than 35 degrees F.

Marigold. They store satisfactorily for up to three weeks from 41 to 45 degrees F in the dark; in the light, you can store them up to five weeks at 41 to 50 degrees F. Do not hold this species for more than three weeks in the dark.

Salvia, Ageratum. They store satisfactorily for up to four weeks from 41 to 50 degrees F in the dark; in the light, you can store them up to six weeks at 41 to 50 degrees F. Optimum storage temperature is 45 degrees F. Handle these two species similarly.

Impatiens. They store satisfactorily for up to four weeks from 45 to 50 degrees F in the dark; in the light, you can store them up to six weeks at 45 to 54 degrees F. Optimum storage temperature is 45 degrees F. Do not store this species below 40 degrees F. High light intensities may cause plant damage.

Cyclamen. They store satisfactorily for up to six weeks from 37 to 41 degrees F in the dark or light. Plants stored for more than four weeks in the dark may experience flowering delay.

Vinca. Optimum storage temperature is 45 to 54 degrees F. Adding light will increase acceptable storage duration time. Do not store this species below 40 degrees F.

There are several ways plugs can be held in a low-temperature area. Many growers are simply reducing temperatures in the greenhouse

where the crop was grown. This may be fine for more short-term holding or where space is not critical. Others have used open benches in lower priority greenhouses, cold frames, open walkways, carts, and even headhouses. Those who continually need long-term storage use refrigerated storage units. These may be either lighted or non-lighted coolers.

A key to successful storage is to provide ample irrigation and good air circulation. If plugs are to be stored for more than a couple of weeks, they should be checked for dryness periodically and irrigated with plain tap water if needed. Irrigate just enough to wet the cell. Plug trays being brought into a warm greenhouse from cold temperature storage should be placed in a low light area and irrigated to avoid wilt. Good air circulation during storage will eliminate the chances for foliar diseases such as Botrytis. Some crops, such as impatiens, are particularly sensitive to attack by these organisms.

Toning Plants to Improve Postproduction Life

A well-toned plug is the key to successful shipping and postproduction handling. Toned plugs are those that are relatively compact with short internodes and a good stem caliper. You want to plug to have a well-developed root system, but not one that is loaded with soft, watery roots. Soft roots can be easily damaged (especially with automatic transplanters), leading to poor establishment and disease problems. Foliage color is also key — you need to keep the plant green, but not to the point where it's a shiny, dark green. That's an indication that the plug has been grown too soft.

How do you grow a nice hard plug? Well, there are a combination of factors that contribute to good, overall toned growth. These include fertilizer rate and formulation, irrigation practices, light intensity, and temperature.

Keeping plants under a high nitrate feed throughout their life cycle will produce toned growth. At Texas A&M, we've had very good results using some of the specially formulated plug blends. These contain primarily potassium, calcium, and magnesium nitrate. The plugs are stockier and more compact than those produced using general purpose fertilizers, such as 20-10-20, 15-16-17, or 20-20-20. Many growers will run their plants lean, especially toward the end of production or if they anticipate holding their plugs. Running plugs too lean during their active growth stages, however, can lead to nutrient deficiencies and poor root and shoot development. Coming in periodically with an ammonium nitrate/ammonium phosphate fertilizer, such as 20-10-20, normally will green the plants up and provide sufficient growth.

A good plug is one that has been grown under careful irrigation management. We think a healthy, full root system is very much determined by watering practices. Most of the successful plug growers run their plugs a little on the dry side. This prevents the soft growth you'll get on both roots and shoots when keeping the media constantly wet. It also helps produce the short, well-branched plug that will handle well during shipping. Several growers have successfully managed fertilizer and irrigation practices to the point where they have drastically minimized growth retardant applications.

Providing the optimum intensity and maximum duration of light for plugs is another important factor leading to toned growth and

successful postproduction. Glass, acrylic, and polycarbonate houses allow for maximum light transmission. Many successful growers in northern climates will provide up to 20 hours of supplemental lighting during the winter or under cloudy growing conditions. Others maximize light intensities by placing stage 4 plugs on benches that can be rolled out of the greenhouse and placed in direct sunlight. This provides for overall tone and vigor while minimizing heat buildup due to the greenhouse effect.

Lastly, temperature control in the greenhouse is a management tool that plug growers can use to control the growth of their plants. Many bedding plant species are responsive to DIF (difference between day and night temperature), and this can be used to maintain compactness of the plug. Keeping early morning temperatures cool will lead to shorter and more toned plants. Unfortunately, DIF can be hard to implement in the southern growing areas of the United States, or where environmental control in the greenhouse cannot be maintained. There has also been evidence to suggest that cooling plugs prior to shipping will improve their postharvest condition when they reach their final destination. This procedure can be analogous to the cooling of fruits and vegetables immediately after harvest to remove field heat. Removing the heat prevents loss of quality during the shipping process.

These suggestions should help growers extend the postproduction life of plugs. Growers should evaluate their own situation and use a combination of management practices to provide a high quality product to their customers.

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~ Virginia Calendar of Events ~

Professional Hort. Conference of VA Virginia Beach, VA	January 19-22
VGGA Board Meeting Radison Virginia Beach, VA	January 20
Tour the State in '98 Tidewater, VA	January 21
VGGA Board Meeting Battlefield Farms	March 3
SE Greenhouse & Trade Show Greenville, SC	June 25-27
VGGA Board Meeting Greenville, SC	June 26
Tour the State in '98 Southwest Virginia	July 28 & 29
VGGA General Meeting Richmond, VA	September 29