e-GRO Alert

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Producing Robust Plugs – Part I

Growing high-quality, seed-propagated bedding plants starts with a robust and toned plug. Judiciously manage crop cultural practices and environmental factors such as substrate moisture, pH and EC, light and temperature to produce the best plugs possible. First up – moisture management!

We are at the beginning of April and the 2019 bedding plant season is coming to a head. Commercial propagators have been shipping out plugs since as early as January, but many greenhouses, particularly in the northern US, have plugs in the final stages of production and are preparing for transplant.

When it comes to producing high-quality, seed-propagated bedding plants, the quality of plugs used greatly impacts the finished product. Though the amount of time a plug spends in production is relatively short, crop cultural and environmental factors affect their growth and quality very quickly. Uniform, vigorous, and floriferous plants are what consumers look for, and growing a plant that fits that bill starts in the plug phase.

At the end of January, one of my e-Gro colleagues (Chris Currey) wrote about improving seed germination/radicle emergence, and cotyledon expansion (often referred to as plug Stages 1 and 2, respectively; see e-Gro Alert 8.05). If you followed Chris' suggestions, you are probably on the right track to producing some great plugs. Over my next few e-Gro Alerts, we will cover best management practices for the final two stages of plug production; true-leaf expansion and toning (Stages 3 and 4, respectively). This week, managing moisture to maintain plug uniformity and encourage rooting will be the focus.

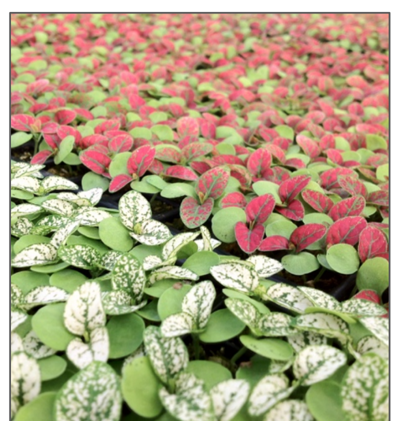

Photo credit: Nicholas J. Flax

Figure 1. Substrate dry-down can be an effective means for controlling growth of tender species such as bedding impatiens (*Impatiens walleriana*). However, drying impatiens down too heavily can cause delay in flowering or permanent physiological damage. This grower attempted to use dry-down as a height control method for these impatiens plugs, and areas highlighted in white were wilted heavily prior to irrigation. Though they have begun to recover, flowering may be delayed and overall uniformity of plugs in this tray may be impacted.

Plug Moisture Terms. Of all of the crop-cultural factors involved in plug production, moisture management is arguably the most important. To ensure that moisture is being managed appropriately, let's discuss plug moisture levels using the 5-point scale. On this scale, moisture level 5 means the substrate has been wetted to saturation. Water can be seen on the substrate surface, it will be very dark in color, and lightly touching the plug's substrate will leave water on the tip of your finger. At moisture level 3, the plug substrate has some available water but it will not be wet to the touch like a 5. For example, if squeezed firmly, a couple of water droplets should fall from a standard 288-cell plug at moisture level 3. Alternatively, at moisture level 1, the plug's substrate will have no available water and will be a light tan color. It will be difficult to re-wet plugs that are dried down to a 1 unless a wetting agent is present in the substrate or irrigation water. See page 3 of Roberto Lopez's article (e-Gro Alert 7.21) for a good visual of the 5-point moisture scale.

Growth & Uniformity. Stage 3 and 4 plugs will begin to stretch in search of light as the canopy of the tray tightens. Leggy, top-heavy plugs can cause down-stream height control challenges for finished plants. Dry-down can be used to curb this stretching response. Some genera respond favorably to heavy dry-down (Fig. 1) while others are less tolerant as plugs (Fig. 2).

Figure 2. Some taxa are less tolerant to dry-down as plugs. For example, stunting and reduced uniformity can result from drying wax begonia (*Begonia semperflorens-cultorum*) down too heavily during Stage 3 (true-leaf expansion).

Growth & Uniformity cont. However, even if controlled drought stress is cited as a non-chemical height control method for genera that you are growing, be aware that drying certain species down too hard or too many times can result in delays in flowering and/or stunting. Be sure to look up moisture optima for different species that you are growing before using dry-down to restrict growth. If dry-down to moisture levels 2–1 are not recommended, consider making a low-concentration foliar application of a plant growth retardant (PGR) to restrict growth.

There are, however, certain aspects of plug growth that should not be managed with PGRs. Particularly in stage 4, seedlings along edges and corners of trays will dry out very quickly compared to those in the inner rows. If unchecked, this dry-down differential can lead to a "bread loafing" effect, where plugs in inner rows are disproportionately taller than those in the outer 1–2 rows (Fig. 3). In a 288-cell plug tray (24 × 12 cells), this translates to lost uniformity across up to 47% of the tray (136 plugs max, between outer 1–2 rows). Continuing to water "bread loafed" plugs without adjusting your irrigation pattern will only worsen the growth differential, and plugs will ultimately need to be trimmed prior to shipping or transplant. If trimming is not possible based on your production schedule, you may be forced to transplant tall, leggy plugs. Transplanting overgrown plugs often results in an uphill battle to produce appropriately sized plants for retail sales. Prevent this scenario entirely by spacing plug trays as they enter Stage 4, and provide additional irrigations to the outer rows between full-tray irrigations to even out the moisture differential.

Figure 3. Inadequate watering of the perimeters of plug trays can lead to a "bread loaf" effect, where seedlings in the centers of trays grow disproportionately taller than those along edges and corners. This often occurs during plug production Stages 3 and 4 (true-leaf expansion and toning, respectively). With two weeks until planting, these plugs may need to be trimmed back and grown out again in order to avoid production challenges caused by tall, leggy transplants. If these plugs were being sold to another greenhouse in 2 weeks, they would certainly be rejected by the customer. Prevent "bread loafing" by spacing plug trays as the canopy density increases during Stage 3, and provide additional irrigations along the outer 1–2 rows between regular, full-tray irrigation or fertigation events.

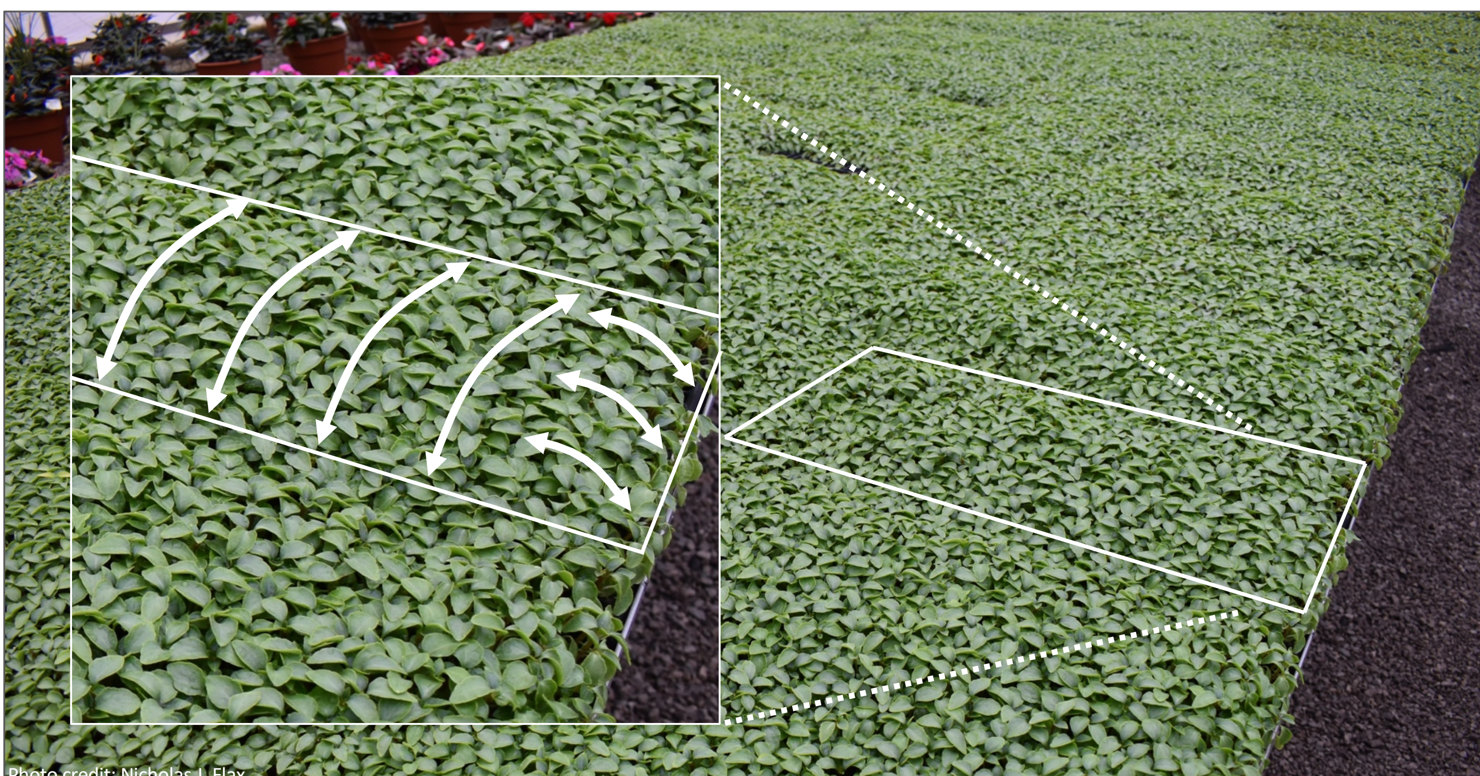

Figure 4. During plug Stage 4 (toning) in particular, a dense seedling canopy can prevent water from fully infiltrating each cell. Check the undersides of trays after irrigations to ensure that adequate water of fertilizer solution was applied.

Growth & Uniformity cont. Additionally, plant species that develop dense leaf canopies in plug trays can create other moisture management challenges. For example, tightly packed leaves of begonias (Fig. 4) can deflect water and fertilizer solution. This causes drought stress across random cells within a given tray, and can result in diminished plug quality. Check the bottoms of trays after irrigation events to ensure adequate water or fertilizer solution was applied. The substrate in dry cells should be much lighter in color than well-watered cells.

Rooting. During Stages 1 and 2, most plant species benefit from higher moisture levels. On the 5-point scale, plug moisture is typically maintained at a 5 to 4 during Stage 1. Moisture levels are often similar in Stage 2, but most plant species are allowed to dry down to a 3 before irrigating again. Once a seedling's radicle has reached the bottom of the plug cell and its cotyledon are unfolded, a plug enters Stage 3. In order to encourage development of a robust root system, thorough wet-dry cycles should be established (Fig. 5A–C).

Figure 5A, B, and C. Establishing thorough wet-dry cycles is an essential part of encouraging the development of a robust root system in plugs. The geranium (*Pelargonium* × *hortorum*) seedling shown in 5A has well-developed roots as a result of good moisture management. The plug from a neighboring tray (5B and C), however, has been overwatered and root systems development has suffered.

Rooting cont. However, dry-down in Stage 3 should be managed carefully. If dried down too severely, damage to roots may occur – especially if moisture levels reach a 1. For disease-susceptible taxa such as annual vinca (*Catharanthus roseus;* Fig. 6), damaged roots can serve as an entry-point for pathogens like phytophthora. Root systems of other more drought-tolerant bedding plant species such as moss rose (*Portulaca grandiflora*; Fig. 7), on the other hand, can benefit from periods of heavier root zone dry-down.

Conversely, if thorough wet-dry cycles are not established in Stage 3, negative down-stream effects will likely occur. Excessive moisture during stage 3 can result in formation of a weak root system, and root growth will concentrate at the top of the plug cell. This can cause challenges at transplant, as poorly rooted plugs will fall apart when removed from their trays. Unless significant care is taken, poorly rooted plugs can be pulled completely out of their substrate. This can compromise the plug as a whole or greatly slow down the transplanting process if extra care is taken in removing each plant from the tray. Time is money, and encouraging a vigorous root system among your plugs can save you both.

To summarize, if plug moisture is managed appropriately throughout Stages 3 and 4, the result should be uniform seedlings with strong root systems. Keep on top of your watering practices in order to maximize your plug quality!

Figure 6. Though establishing wet-dry cycles is an important crop cultural practice to encourage development of a robust root system in plugs, excessive drought stress should be avoided when growing certain taxa. Damaged roots due to excessive dry-down among vinca (*Catharanthus roseus*), for example, can be an entry point for root-rot pathogens like phytophthora.

Figure 7. Drought-tolerant taxa such as moss rose (*Portulaca grandiflora*) are more receptive to heavy dry-down as a means for encouraging root growth than other, tender plant species.

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