

## Preventing Non-Phosphorous Related Purpling in Unrooted Cuttings



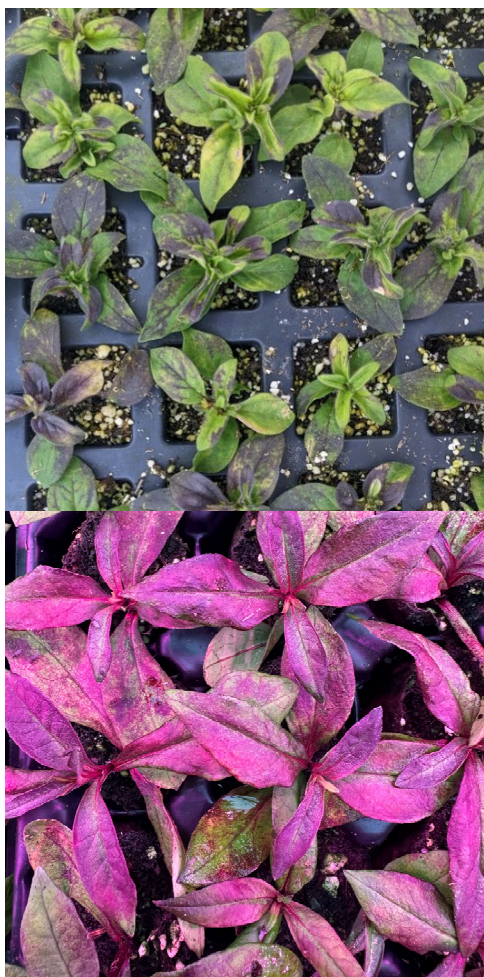
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*Undesirable purpling of unrooted cuttings propagated under LED supplemental lighting can be mitigated by adjusting air or root-zone temperature or the supplemental lighting intensity.*

When sunlight levels are low, supplemental lighting (SL) can accelerating rooting and liner quality. While SL has conventionally been provided by high-pressure sodium (HPS) lamps, light-emitting diodes (LED) fixtures are becoming the new standard because their numerous benefits, including longer lifespans, lower heat output, lower energy capacity, and greater energy efficiency. However, crops may respond differently to the light emitted by LEDs, depending on the spectral output of the fixtures. As LED technology evolves, and fixtures continue to emit higher intensities of light, LED SL may yield undesirable crop responses in sensitive cultivars of petunia, Reiger begonia, phlox, etc., when rooted as cuttings. Among these unwanted responses, purple foliage development during propagation is observed in plants with red, purple, or dark pink flowers (Fig. 1). Leaf purpling results from the accumulation of red and blue pigments called anthocyanins. These compounds can accumulate for a variety of reasons, including low temperatures, exposure to high-intensity light, exposure to short- wavelength light (such as blue or ultraviolet light), or nutrient deficiencies. During the propagation of unrooted cuttings, one might assume that foliage purpling is due to nutrient deficiency, most likely phosphorus (P). However, while P deficiency manifests as lower-leaf purpling (Fig. 2), purpling from high-intensity LED SL appears as a



**Figure 1. Discolored petunia and phlox cuttings rooted under high-intensity LEDs.**

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spotchy or mottled discoloration on foliage directly exposed to the light, regardless of leaf age (Fig. 3). The development of this discoloration, while varying between species and cultivars, often results in unmarketable rooted liners. Our research at MSU indicates that simple changes in environmental conditions, such as air or root-zone temperature or SL intensity, can prevent or mitigate purpling, enabling the widespread use of LED SL during propagation without undesirable effects.

### Adjusting Temperature

A major difference between the emission spectra of LEDs and HPS lamps is that LEDs emit less infrared radiation (heat) than HPS lamps. Under HPS lighting, this thermal radiation directly heats the crop, increasing plant temperature by 2 to 4 °F. Again, because the energy efficiency of modern LED fixtures in converting electricity into light is much greater than that of HPS lamps, they emit far less heat, and plants grown under them are comparatively cooler. The combination of high light and lower leaf temperature can increase the production and accumulation of anthocyanins, increasing the likelihood of foliar purpling in cultivars that produce anthocyanins for colorful flowers. When using LED SL, to compensate for the lack of thermal radiation in the emission spectrum, plant temperatures can be raised by increasing air temperature, by using root-zone heating, or both. While air temperature is the most prominent environmental factor influencing this purpling issue, our research has revealed that each method of increasing plant temperature can prevent this unwanted foliage discoloration (Figs. 4, 5, and 6).

### Limiting SL intensity

Modern LED fixtures emit a relatively high light intensity compared to fixtures 5+ years ago, and it is not uncommon for growers to deliver SL at  $\geq 100 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  as well as a fair amount of blue light. Both of these factors can contribute to the synthesis and accumulation of anthocyanins in foliar tissues. By reducing the light intensity at crop height (which can easily be done through the use of adjustable fixtures), light stress can be limited during the first 7-10 days after stick (stages 0 and 1), and purpling can be mitigated. Another, perhaps more practical, way to mitigate the negative effects of high-intensity LED SL is to limit the supplemental photoperiod, or the amount of time the LEDs are on throughout the day. Our studies show that the emission spectrum of high-intensity SL influences crop morphology and coloration when it accounts for more than 40% of the total light incident on a crop, as measured by the



Figure 2. Lower-leaf purpling in petunia from phosphorus deficiency. (Photo: Brian Whipker)



Figure 3. Purpling in petunia cuttings from exposure to high-intensity LED supplemental lighting.



Figure 4. Petunia rooted at air and root-zone temperatures of 70 and 70 °F.

daily light integral (DLI). As the amount of light that is composed of SL increases, the influence of the SL spectrum on crop responses becomes stronger as well. Thus, by monitoring solar light levels and adjusting the SL photoperiod to account for only about 40% of the total DLI, purpling can be mitigated. For example, during peak propagation months (Jan. through Mar.), it is not uncommon for propagation environments to only receive 4 to 7  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$  of sunlight. From this, a grower using LED fixtures at an intensity of  $120\ \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  should only have them on for about 11 hours each day to ensure that SL is making up 40% of the total DLI ( $120\ \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1} \times 60\ \text{s} \times 60\ \text{min} \times 11\ \text{h} / 1,000,000 = 4.7\ \text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ; Fig. 7). Something important to mention is that lower-intensity SL can make up a larger share of the total DLI before negatively affecting a crop. For example, deleterious crop responses from LEDs emitting  $80\ \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  tend to occur once SL accounts for about 50% of the total DLI.

### Conclusion

LED fixtures are an increasingly popular SL option that offer numerous benefits over traditional lighting sources. However, LEDs emit little thermal radiation and a moderate amount of blue light onto a crop, which can both lead to the development of purple leaves during the rooting of unrooted cuttings at high light intensities ( $\geq 120\ \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ). To prevent this purpling, raise plant temperatures by increasing air temperature by 2 to 4 °F or deliver root-zone heating. Alternatively, limit the time LEDs are on throughout the day during the first 6 to 10 days of propagation so that LED light accounts for ~40% of the total DLI.



Figure 5. Petunia rooted at air and root-zone temperatures of 73 and 70 °F.



Figure 6. Petunia rooted at air and root-zone temperatures of 70 and 75 °F.



Figure 7. Petunia Sureshot 'Blue' rooted under LED supplemental lighting at an intensity of  $120\ \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  where the supplemental light accounts for 30, 40, 50, or 60% of the total amount of light (daily light integral) at plant height.

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