American Journal of Plant Sciences, 2026, 17(9), 925-931
https://www.scirp.org/journal/ajps
ISSN Online: 2158-2750
ISSN Print: 2158-2742

Far-UV Radiation Exposure of Plant Leaves: Observed Damage and Survival

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How to cite this paper: Forbes, P.D., Welch, D., Hashmi, R., Buonanno, M. and Brenner, D.J. (2026) Far-UV Radiation Exposure of Plant Leaves: Observed Damage and Survival. *American Journal of Plant Sciences*, **17**, 925-931.
https://doi.org/10.4236/ajps.2026.179056

Received: June 8, 2026
Accepted: September 20, 2026
Published: September 23, 2026

Abstract

Far-UVC technology is a promising intervention to limit the spread of disease in occupied spaces. One unanticipated effect from the introduction of far-UVC radiation to indoor spaces is the impact on indoor plant health. Anecdotal reports have suggested that *Poinsettia* plants, when kept in a room where they were exposed to far-UVC radiation, exhibited visible discoloration, drooping and wilting. In this study, various plants were exposed to controlled doses of far-UVC radiation and their health was monitored. Across several genera and species of plants that display varying degrees of red coloration in leaves, the sensitivity to far-UVC ranges from substantial to visually undetectable. The observed changes warrant further mechanistic investigation to provide practical information about installation of far-UVC fixtures in rooms with decorative plants.

Keywords

Ultraviolet Radiation, Far-UVC, Poinsettia

1. Introduction

Several studies have shown that far-UVC light wavelengths in the range of 200 - 235 nm are highly germicidal while posing minimal health risk to humans. Continuous operation of far-UVC lamps has been proposed as a practical tool to reduce the transmission of infectious diseases in occupied indoor locations [1]-[3].

Responsible deployment of far-UVC technology involves a balance: not only efficacy in infection mitigation plus safety for people in the vicinity, but also an awareness of unanticipated effects. Among the latter are anecdotal reports relating full-room exposure with germicidal ultraviolet light (GUV) to leaf wilting and color change in a variety of the decorative plant *Poinsettia*. In fact, both harmful and beneficial effects of UV radiation on plant growth had previously been noted [4]-[7]. Our preliminary plant studies involved principally poinsettias. The initial findings were presented at the second meeting of the International Conference for Ultraviolet Science and Technology (ICFUST) in 2024 [8]. The initial evidence of damage to poinsettias was discoloration in the predominantly red bracts (plant upper leaves). With short-term exposures, the plants survived and produced new, normally colored leaves, but without recovery of the original leaf coloration. The predominance of damage in the red-pigmented leaves led us to investigate the possible sensitivity to far-UVC in other plants displaying red pigment (presumably either anthocyanins or betacyanins) in their leaves [9]. Here we review the initial findings and then compare differing responses among these plant varieties. The objective of this report is not to determine mechanisms of plant injury or to establish far-UVC dose-response relationships, but rather to document an unexpected response encountered during development of far-UVC applications, and to provide qualitative comparisons among several plant species, along with guidance for future investigations and far-UVC applications.

2. Methods

2.1. Lamps and Dosimetry

The far-UVC lamp used for this study was a KrCl excimer lamp emitting principally at 222 nm (Ushio Care-222, Ushio America, Cypress CA). The Care-222 unit includes an optical filter to significantly reduce emissions from wavelengths > 230 nm. Plants were exposed from above at ambient temperature (20˚C) and a relative humidity between 40% - 50%.

Dosimetry was performed using radiochromic film (OC-1, Orthochrome Inc., Hillsborough, NJ). The film exhibits an instantaneous color change when exposed to ultraviolet radiation, and we have previously characterized the film and shown its utility in a variety of ultraviolet radiation dosimetry applications [10]-[14].

2.2. Experimental Design

<u>Poinsettia single exposure:</u> Following up on the Poinsettia anecdotal observations, several treatment protocols were used to expose selected plant varieties under controlled lighting conditions (e.g., Arabidopsis, radish seedlings, Vinca, northern bristle), producing adequate evidence of exposure/response relationships. While executing the preliminary studies we raised mature "red" poinsettia plants from greenhouse cuttings; using those plants (both developing and mature), we observed dose-related exposures using an Ushio Care-222 filtered KrCl excimer lamp to leaf response. Initially, the plants had some leaves covered and the remainder not covered. In these preliminary studies, entire plants were first exposed over a single 5-hour period with an estimated radiant exposure of 100 mJ/cm^2.

<u>Poinsettia repeated exposures</u>: The setup was then modified to provide a lower intensity exposure resulting in a daily dose of 10 - 12 mJ/cm^2 delivered over the 5-hour period. The lower intensity setup was used to expose several variety of plants

daily, over a period of up to 7 weeks.

Comparative plant study: Additional testing was performed on plants exhibiting red coloration in their leaves. The plants included: polka dot plant (*Hypoestes red variant*); coleus (Painted Nettle; *Coleus scutellariodes*); rex begonia (*Begonia rex-cultorum*); mini red veined nerve plant (*Fittonia albivenis*); romaine red lettuce (*Lactuca sativa L. var. longifolia*); ornamental sweet potato vine (*Ipomoea batatas*); red beet starter plants (*Beta vulgaris*, Bloodleaf); mini tradescantia succulent (*Tradescantia Blossfeldiana cerinthoides variegata* "Lilac"); and sedum succulent (Coppertone Stonecrop; *Sedum nussbaumerianum*).

For studies comparing plants exhibiting red coloration in leaves, the UV exposure duration was one hour on day one followed by two hours daily for six days. Film dosimetry was used to estimate the dose received upon the leaves of the plants by attaching films directly to the leaves during exposure. The estimated radiant exposure in one hour ranged from 10 - 12 mJ/cm^2, which suggests an average irradiance of 2.8 - 3.3 µW/cm^2.

The visual criteria we used can be described as the following: pigment loss as bleaching or fading of greenness; wilting as desiccation or dehydration; discoloration as browning or color change; and survival as the plant viability and recovery.

For all of these studies, visual comparisons between members of each pair ("UV-treated" and "control") were recorded and photographed. Considering the observational nature of the study design and the small sample size for each set of exposure conditions, no formal statistical analysis was undertaken.

All the plants were purchased from the commercial supplier, which did not provide the cultivar and developmental stage of each plant. Allocation of the plants to control and UV-exposure groups was random.

3. Results and Discussion

In preliminary studies, a visible color blanching was observed within 24 hours in leaves of the poinsettias exposed to the single dose of 100 mJ/cm^2 from the far-UVC lamp (**Figure 1(A)**). Notably, only uncovered leaves which were directly exposed to the far-UVC light exhibited blanching, while unexposed areas of leaves were unchanged in appearance.

Follow-up studies on poinsettias involved UV at the lower intensity, which delivered an estimated daily radiant exposure of 10 - 12 mJ/cm^2. Under these conditions, leaf discoloration became evident after 2 - 3 weeks of whole-plant exposures, with severe plant wilting 2 - 4 weeks later. Thus, we concluded that under exposure conditions reasonably similar to those of decorative plants in a realistic public setting, far-UVC exposures can lead to detrimental changes in poinsettia. It is important to note that for these studies, two to four pairs of each variety of individually potted plants were illuminated 12 hours daily under LED plant growth fixtures emitting visible light. One member of each pair was periodically moved to an actively ventilated plant growth tent (Vivosun, Ontario, CA) for exposure to a Care-222 filtered lamp. However, while in the tent, the UV-exposed member of the pair received no LED illumination.

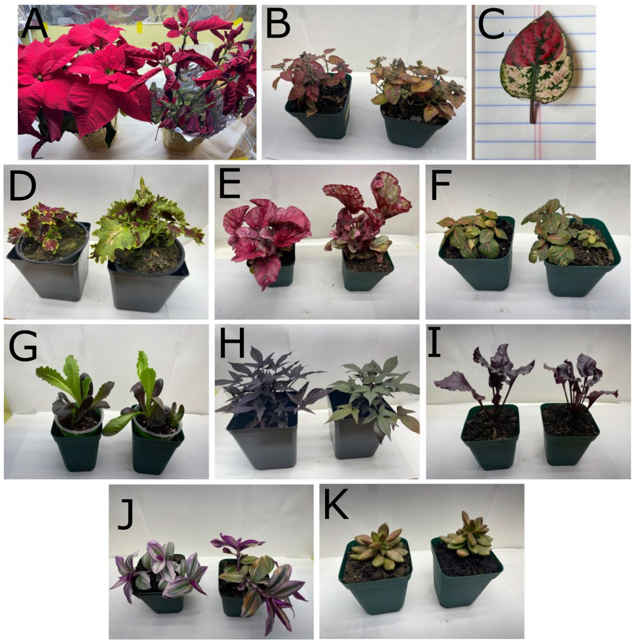

Figure 1. A) Poinsettia plants shown with unexposed control on left and plant exposed to far-UVC on the right. B) Polka dot plant shown with unexposed control on left and plant exposed to far-UVC is on right. C) A polka dot plant leaf removed several weeks after the end of exposures. D) An unexposed coleus is shown on the left and a far-UVC exposed coleus plant is on the right. E) A far-UVC exposed rex begonia is on the left and an unexposed plant on the left. F) An unexposed mini red veined nerve plant is on the left and a far-UVC exposed plant is on the right. G) An unexposed romaine red lettuce plant is shown on the right and a far-UVC exposed plant is on the left. H) A far-UVC exposed ornamental sweet potato vine is on the left and an unexposed plant on the left. I) A red beet starter plant exposed to far-UVC is on the left and an unexposed plant is on the right. J) An unexposed mini tradescantia succulent is on the left and a far-UVC exposed plant on the right. K) A sedum succulent exposed to far-UVC is on the left, and an unexposed plant is on the right.

3.1. Far-UVC Exposure of Polka Dot Plant

Figure 1(B) shows a photo of an unexposed (left) and exposed (right) polka dot plants. Each exposed plant in this section received a total of approximately 143 mJ/cm^2 of 222 nm far-UVC.

All exposed leaves lost some red pigment by the end of the first exposure, and the remainder lost by the end of the third exposure. Some lower leaves were partially shaded by leaves above, and the shaded areas retained pigment. Bleached spots did not recover pigment, though the plants survived and subsequently produced new leaves with intact pigment spots.

Figure 1(C) shows a plant leaf that was removed several weeks after the end of exposures, at a time when all exposed areas of leaves were substantially devoid of red pigment. This leaf had been partially shaded by an overhanging leaf. The shaded area remained red, but the exposed area did not recover red coloration.

Meanwhile, following exposure, the plant had grown new leaves, all with normal-appearing red coloration.

In a separate study the polka dot plants were under LED illumination during a single far-UVC exposure. In that case, the depletion of red coloration was much less evident (*i.e.*, comparable to a plant receiving half the far-UVC "dose" and no LED illumination). This emphasizes the complex nature and functions of leaf pigments [9].

3.2. Far-UVC Exposure of Coleus

Figure 1(D) shows a far-UVC exposed coleus on the right. All exposed coleus leaves lost some red pigment by the end of the first exposure (10 - 12 mJ/cm^2) and lost the remainder by the end of the last exposure (130 - 156 mJ/cm^2 cumulative radiant exposure); by that time, substantial wilting was evident.

3.3. Far-UVC Exposure of Rex Begonia

Figure 1(E) shows a far-UVC exposed rex begonia on the left. Exposed begonia leaves retained substantial amounts of red pigment throughout, but the exposed plants exhibited discoloration and some wilting and disfiguration.

3.4. Far-UVC Exposure of Mini Red Veined Nerve Plant

Figure 1(F) shows a far-UVC exposed mini red veined nerve plant on the right. Nerve plants initially displayed red coloration visible only along the "veins" of the leaves; no leaf change in exposed plants was evident.

3.5. Far-UVC Exposure of Romaine Red Lettuce

Figure 1(G) shows a far-UVC exposed romaine red lettuce plant on the left. The lettuce leaves retained red pigment in both the upper and under surfaces but showed some signs of a mild wilting response.

3.6. Far-UVC Exposure of Ornamental Sweet Potato Vine

Figure 1(H) shows a far-UVC exposed ornamental sweet potato plant on the left. The ornamental ipomoea leaf displayed a very deep red hue on both the upper and under surfaces prior the GUV exposure. The upper (exposed) surfaces permanently lost all red hue, resulting in a green-appearing leaf; the under surfaces retained their deep red coloration. Otherwise, the exposed plants retained most of their pre-exposure appearance.

3.7. Far-UVC Exposure of Red Beet Starter Plants

In Figure 1(I), a far-UVC exposed red beet starter plant is shown on left. The exposed beet plant leaves retained their pre-exposure color, but not all retained a smooth texture, possibly suggesting moisture loss. Note that the beet plant reportedly is characterized by red betacyanin pigment [9], whereas the other eight plant varieties by anthocyanins.

3.8. Far-UVC Exposure of Mini Tradescantia Succulent

Figure 1(J) shows a far-UVC exposed mini tradescantia succulent plant on right. Some of the tradescantia's faint coloration was diminished on the upper leaf surfaces, while the undersurfaces retained their deep red hues. Mild wilting was also noted.

3.9. Far-UVC Exposure of Sedum Succulent

Figure 1(K) shows a far-UVC exposed sedum succulent on the left. Other than a barely discernable reduction in red highlights, the exposed sedum plants retained their pre-exposure appearance.

4. Conclusion

In summary, across several genera and species of plants that display varying degrees of red coloration in leaves, the visible response to far-UVC (under specified exposure conditions) ranges from substantial (poinsettias, polka dot plant) to intermediate (ornamental sweet potato vine) to visually undetectable (nerve plant, sedum succulent). These qualitative observations relied on visual assessments of plant appearance and were intended to document the occurrence of an unexpected phenomenon. Despite their qualitative nature, our observations indicate that plant species differ in their apparent visual response to far-UVC. Thus, selected plant species may warrant further mechanistic investigation, including measurements of chlorophyl content, anthocyanin concentration, leaf water content measurements, and photosynthetic efficiency, to provide practical information for deployment of far-UVC radiation in indoor location with ornamental plants.

Acknowledgements

We are grateful to Ushio America, Inc. for providing P.D.F. with a Care-222 source at no cost. The study was funded by Open Philanthropy/Good Ventures Foundation; Blueprint Biosecurity; Flu Lab; Far UV Foundation; and the Columbia University Urban Tech Award.

Author Contributions

Conceptualization, P.D.F.; methodology, P.D.F., D.W.; formal analysis, P.D.F., D.W., R.H., M.B.; investigation, P.D.F., D.W., R.H., M.B.; resources, D.J.B.; data curation, P.D.F., D.W., R.H.; writing—original draft preparation, P.D.W., D.W., M.B.; writing—review and editing, P.D.F., D.W., R.H., M.B., D.J.B.; supervision, D.J.B.; funding acquisition, D.J.B. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Bergman, R., Brenner, D., Buonanno, M., Eadie, E., Forbes, P.D., Jensen, P., *et al.* (2021) Air Disinfection with Germicidal Ultraviolet: For This Pandemic and the Next. *Photochemistry and Photobiology*, **97**, 464-465. https://doi.org/10.1111/php.13424

[2] Görlitz, M., Justen, L., Rochette, P.J., Buonanno, M., Welch, D., Kleiman, N.J., *et al.* (2024) Assessing the Safety of New Germicidal Far-UVC Technologies. *Photochemistry and Photobiology*, **100**, 501-520. https://doi.org/10.1111/php.13866

[3] Blatchley, E.R., Brenner, D.J., Claus, H., Cowan, T.E., Linden, K.G., Liu, Y., *et al.* (2023) Far UV-C Radiation: An Emerging Tool for Pandemic Control. *Critical Reviews in Environmental Science and Technology*, **53**, 733-753. https://doi.org/10.1080/10643389.2022.2084315

[4] Janisiewicz, W., Takeda, F., Evans, B. and Camp, M. (2021) Potential of Far Ultraviolet (UV) 222 Nm Light for Management of Strawberry Fungal Pathogens. *Crop Protection*, **150**, Article 105791. https://doi.org/10.1016/j.cropro.2021.105791

[5] Nawkar, G., Maibam, P., Park, J., Sahi, V., Lee, S. and Kang, C. (2013) UV-Induced Cell Death in Plants. *International Journal of Molecular Sciences*, **14**, 1608-1628. https://doi.org/10.3390/ijms14011608

[6] Gerdt, A., Gierke, A., Vatter, P. and Hessling, M. (2025) Effect of Far-UVC and Violet Irradiation on the Microbial Contamination of Spinach Leaves and Their Vitamin C and Chlorophyll Contents. *Biology and Life Sciences Forum*, **47**, Article No. 1. https://doi.org/10.3390/blsf2025047001

[7] Claus, H. (2023) The Influence of 222 nm UV-C Radiation on Plants. https://zenodo.org/records/19223768

[8] Forbes, P.D. (2024) Leaf wilting in Poinsettia Plants Exposed to Far GUV. 2024 *Intentional Congress of Far-UVC Science and Technology* (*ICFUST*), University of St. Andrews, 18-21 June 2024.

[9] Fernández-López, J.A., Fernández-Lledó, V. and Angosto, J.M. (2020) New Insights into Red Plant Pigments: More than Just Natural Colorants. *RSC Advances*, **10**, 24669-24682. https://doi.org/10.1039/d0ra03514a

[10] Welch, D. and Brenner, D.J. (2021) Improved Ultraviolet Radiation Film Dosimetry Using Orthochromic OC-1 Film. *Photochemistry and Photobiology*, **97**, 498-504. https://doi.org/10.1111/php.13364

[11] Welch, D., Hashmi, R., Petersen, C., Erde, S., Brenner, D.J. and Nardell, E. (2024) Film Dosimetry for Occupant Exposure Monitoring within Far-UVC Installations. *Photochemistry and Photobiology*, **101**, 157-166. https://doi.org/10.1111/php.13960

[12] Welch, D., Randers-Pehrson, G., Spotnitz, H.M. and Brenner, D.J. (2017) Unlaminated Gafchromic Ebt3 Film for Ultraviolet Radiation Monitoring. *Radiation Protection Dosimetry*, **176**, 341-346. https://doi.org/10.1093/rpd/ncx016

[13] Duncan, M.A., Welch, D., Shuryak, I. and Brenner, D.J. (2022) Ocular and Facial Far-UVC Doses from Ceiling-Mounted 222 Nm Far-UVC Fixtures. *Photochemistry and photobiology*, **99**, 160-167. https://doi.org/10.1111/php.13671

[14] Hashmi, R., Meeker, S., Rockwood, M., Rockwood, K., Petersen, C., Brenner, D.J., *et al.* (2026) Ultraviolet Radiation Dosimetry Using Radiochromic Film for Extended Dose Range Applications and Estimating Eye Exposure. *Radiation Protection Dosimetry*, **202**, 555-561. https://doi.org/10.1093/rpd/ncaf186