Abstract

Ultraviolet (UV) radiation is a constituent of sunlight that influences plant morphology and growth. Due to the depletion of the ozone layer, the level of Ultraviolet-B (UV-B) with a wavelength range of 280–320 nm, has been increasing on the earth’s surface. UV-B has been shown to induce photomorphogenic responses and cause damage to biomolecules in plants. However, the signaling molecules involved in the photomorphogenic response are unknown. Previous research on other stresses such as drought and heat have identified reactive oxygen species (ROS), toxic byproducts of cellular respiration, as signaling molecules in plants. This research examined the role of ROS as a signaling molecule in Arabidopsis thaliana seedlings exposed to UV-B. Mutant lines for genes responsible for ROS as well as chemicals that interfere with ROS accumulation were used along with UV-B light. The results obtained suggest that ROS may play a signaling role in plants exposed to UV-B light.

Introduction

Effect of UV-B on Plant Growth

UV-B (280–320 nm) reduces hypocotyl elongation in growing Arabidopsis thaliana seedlings (Gardner et al. 2009) and causes damage to biomolecules such as DNA, RNA and protein (Biever et al. 2014).

• The basis of these responses has not been well studied, and may be considered as a general reaction to stress (Borsche et al. 2003).

Role of Reactive Oxygen Species

• ROS play an important signaling role in plants controlling processes such as growth, development, response to biotic and abiotic environmental stimuli, and programmed cell death (American Society of Plant Biologists, 2006).

• During drought, heat, wounding and high-light stress, ROS accumulates at the site of stress (local) and away from the site of stress. This results in systemic signaling (Miller et al. 2009).

Focus of Study and Implications

• Examine the role of ROS in etiolated Arabidopsis seedlings exposed to UV-B by using the NADPH flavin-oxidase inhibitor diphenylethyleniodium (DPI) and the mutant line, ascorbate peroxidase (aps2-1).

• The results will hopefully determine whether ROS has a role in response signaling following UV-B exposure.

Materials

Mutant A. thaliana seeds: aps2-1, was provided by Professor Ron Mittler at the University of North Texas. NADPH flavin-oxidase inhibitor diphenylethyleniodium (DPI) and the mutant line, ascorbate peroxidase (aps2-1).

UV light sources

UV light sources utilized are as described in Gardner et al. (2009). Broad-band UV-B light (FS40-T12-UVB-BP fluorescent tubes, UV Lighting Co., Brook Park, OH, USA) was used for fluence response analyses.

Methods

1) 20-30 seeds of A. thaliana were planted on filter paper in a 10 cm Petri dish containing 0.7 ml ½ strength MS and 100 mm GA3 or GA4.

2) When the radicles emerged (2-3 days after planting), DPI was applied (for DPI+UV-B test only) and each plate was irradiated with total fluences of 3x10^-4, 10^-4, 3x10^-4, or 10^-4 μmol m^-2.

Results: Inhibition of Hypocotyl Elongation by DPI

• Application of 10 μM DPI did not affect hypocotyl growth (Fig. 4).

• Hypocotyl growth was decreased by ~50 % by addition of 50 μM DPI.

Results: Inhibition of Hypocotyl Elongation by U-VB

• Fluence response curve shows the mutant line aps-3 to be more sensitive to UV-B than the wild type Col-0. (Fig 5) This is consistent with previous results (Biever et al. 2014)

• Mutant line apx2-1 is more sensitive to UV-B irradiation than the wild type at fluences of 3,000 and 10,000 μmol m^-2 of UV-B.

• Mutant apx2-1 acts similar to the wild type Col-0 after 30,000 and 100,000 μmol m^-2 of UV-B

References


Acknowledgments

I would like to thank Dr. Gary Gardner for his willingness to involve me in his research and for being a great mentor. I would also like to thank Doug Brinkman for all his help throughout my research. In addition to the Department of Horticultural Science and the McNair staff have been very supportive and helpful.