GLOBAL JOURNAL OF AGRICULTURAL AND ALLIED SCIENCES (2025) VOL 5, S 2, PAGES 13-14

EXTENDED ABSTRACT
NAPA 2024 Conference Special Issue

Low-Temperature Plasma: A Green Technology for Improving Crop Productivity and Seed Safety

Srinivasa Rao Mentreddy*[1], Trang Pham[1], Sravan Kumar Sanathanam[1], Leopold Nyochembeng[1], and Kunning Gabriel Xu[2]

[1]*Department of Natural Resources and Environmental Sciences, Alabama A&M University, Huntsville, Alabama 35811, USA*
[2]*Department of Mechanical and Aerospace Engineering, University of Alabama in Huntsville, Huntsville, Alabama 35899, USA*

Abstract history:
Received: June 18, 2024
Revised: February 17, 2025
Accepted: February 18, 2025

Keywords: Drought tolerance, Germination, Microgreens, Low-temperature plasma, Seed-borne pathogens

Agricultural production must innovate environmentally friendly green technologies to improve crop productivity and ensure the sustainable production of nutrient-rich and disease-free foods during the era of climate change. Low-temperature plasma (LTP) is a partially ionized gas with unbound electrons, ions, neutral particles, reactive nitrogen species, reactive oxygen species, and ultraviolet light. The LTP is emerging as a viable non-chemical tool for breaking seed dormancy, hastening seed germination, improving crop productivity, and disinfecting seeds and foods, among other uses. The objectives of this research were to assess LTP for (1) improving crop productivity through early seed germination, crop growth, and drought tolerance, and (2) controlling seed-borne pathogens.

(1) To evaluate the crop productivity using LTP, mustard greens seeds were exposed to argon (Ar) or helium (He) LTP at a fixed power setting of 6 kV, 1 µs pulse width, 6 kHz, and three standard liters per minute of gas flow for 0 s (Control), 30 s, 60 s, and 90 s. The treated or untreated seeds were sown at two seeds per pot containing potting mix and placed in a greenhouse. Seed germination, seedling height, seedling biomass, and root length were recorded. All data were submitted to statistical analysis using R-Studio statistical software.

(2) To evaluate the efficacy of LTP in controlling seed-borne pathogens the sweet bell pepper (*Capsicum annuum*) seeds were inoculated with *Xanthomonas campestris* pv. *vesicatoria* (*Xcv*) obtained from the American Type Culture Collection. The *Xcv* cells were treated with argon gas LTP at 6kV and 8kV with a flow rate of 1.41 each for 4, 6, and 8 minutes. The treated and untreated bacteria were observed under scanning electron microscope at 1 µm scale.

LTP effects on crop productivity: The percentage of seed germination increased by 40% with the exposure of seeds to He LTP for 30 seconds compared to the control ($p \leq 0.5$) (Fig. 1a). The seedling height was increased by all Ar and He LTP treatments except Ar LTP at 90 seconds (Fig. 1b). The increase in seedling height ranged from 13.5% for Ar LTP at 60 seconds to 52.6% for He LTP at 60 seconds, compared to the control. The fresh seedling biomass was greater than the control in all He LTP treatments ($p \leq 0.5$) (Fig. 1c). Exposure of seeds to He LTP for 30, 60, and 90 seconds increased the seedling fresh biomass by 8.1, 164.9 and 113% compared to the control. Ar LTP treatments did not influence the seedling fresh biomass. The root length of seeds treated with Ar LTP for 30 seconds increased significantly over all treatments (Fig. 1d). Ar or He LTP treatment of seeds significantly influenced seed germination, seedling growth, and seedling fresh biomass.

LTP effects on seed-borne pathogens: The *X. campestris pv. vesicatoria* cells were rod-shaped and more unified in the Control (Fig. 2a). In contrast, the bacterial cells became curvier, swollen, and aggregated, and cell walls were destroyed in some bacterial cells with LTP (Fig. 2b). This study demonstrated that Ar or He LTP can be used to improve crop productivity and control seed-borne pathogens. Further research is needed to determine the mode of action of LTP in improving seed germination, seedling growth, and destroying seed-borne pathogens.

* *Corresponding author.* E-mail address: srinivasa.mentreddy@aamu.edu

https://doi.org/10.35251/gjaas.2025.007

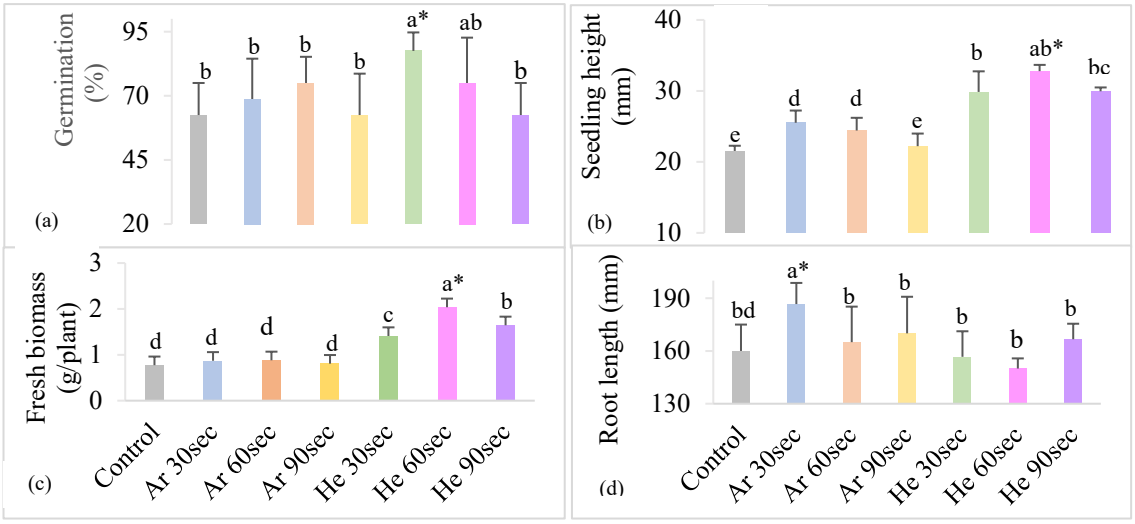

Figure 1. Seed germination (a), seeding height (b), seedling biomass (c), and root length (d) of laboratory-grown mustard greens treated with low-temperature argon (Ar) or helium (He) plasma for 30, 60, or 90 seconds (sec), 2023, Alabama A&M University, Alabama, USA (*p ≤ 0.05).

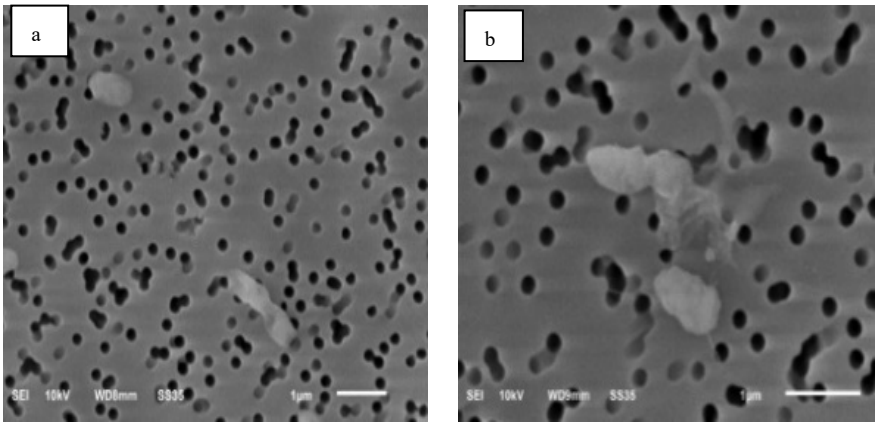

Figure 2. Scanning electron microscopy images of Xanthomonas campestris pv. vesicatoria without plasma treatment (a) and with plasma treatment at 8 kV for 8 minutes at 1 µm scale (b), 2023, Alabama A&M University, Alabama, USA.

Citation: Mentreddy, S. R., Pham, T., Sanathanam, S. K., Nyochembeng, L., & Xu, K. G. (2025). Low-temperature plasma: green technology for improving crop productivity and seed safety. *Global Journal of Agricultural and Allied Sciences,* 5(S2), 13-14 https://doi.org/10.35251/gjaas.2025.007.