Identifying the molecular effects of non-thermal plasma treatments on plant seed development using gene expression and gene reporters

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Abstract: Plasma agriculture is a rapidly emerging interdisciplinary field where non-thermal plasmas are used to treat heat-sensitive biological substrates, such as seeds and plants. When dosed adequately, plasma-treated seeds are observed to have accelerated germination, enhanced growth, reduced water consumption, increased crop yield and disease resistance, and decreased levels of microbial pathogens.

Currently, more is known about how non-thermal plasma influences the macroscopic properties of plants but little is known about how plants are affected on a molecular level. Furthermore, it remains unclear which component (reactive species, heat, electric or magnetic fields, UV) are responsible for an observed plasma effect on seeds and their subsequent development. Here, we use Dielectric Barrier Discharge (DBD) treatments of the model plant organism *Arabidopsis thaliana* Columbia-0 to investigate the underlying molecular effects of plasma treatments.

Plant seeds and germinated seedlings are first exposed to DBD plasmas, to identify conditions yielding a phenotypic change in plant parameters including, but not limited to, germination properties, root length, leaf area and biomass. Variables during the treatment, such as time of exposure, distance, reactor design (surface or volumetric DBD), as well as voltage waveform (AC and nanopulse) are considered. Plasma-treated plants are then analyzed to gather information about their gene expression profile, using targeted qPCRs and ultimately a total unbiased RNA-seq analysis. We investigate genes that respond specifically to plasma, if present, or at the very least correlate the phenotype with changes in the expression of specific genes. Using nano-luciferase as a reporter gene, plasma results will be corroborated and compared to the plant response to heat stress or oxidative stress. The first results from these experiments are presented here.

Keywords: non-thermal plasma, *Arabidopsis*, DBD, germination, seeds, molecular biology