Unraveling surface effects for improving the germination of barley seeds: from drying to air plasma treatments

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Abstract: In this work, we present an analysis of the main factor involved in the germination of mature barley seeds subjected to atmospheric air plasma treatments and, for comparison, to a mild drying and a hydrogen peroxide (H_2O_2) treatments at ambient temperature. We studied the effects of short plasma treatments on germination, in petri dish and in substrate as well as on the surface contamination in vitro conditions. Analysis of the water uptake has been carried out by different methodologies for the plasma treated seeds compared with dried ones.

Keywords: Air Plasma, Barley seed, Germination, Contamination, Water uptake, Abscisic acid, H_2O_2, RONS.

1. Germination of barley seed under air plama treatments, drying and H_2O_2 treatments

In the quest for improving agriculture culture yields, various strategies have been developed to improve germination efficiency and accelerate the first stages of plant growth. One of these strategies consists of treating the seeds with air plasmas [1]. The effects that plasma treatment achieves on seed germination are now well recognized. The surface of seeds becomes hydrophilic after the air plasma action, however this need not be directly related to an improvement in germination due to an increase in the water uptake capacity. [2] In this work, we present an analysis of the main factor involved in the germination of mature barley seeds subjected to atmospheric air plasma treatments and, for comparison, to a mild drying and a hydrogen peroxide (H_2O_2) treatments at ambient temperature. Short plasma treatment times (1, 3 and 7 minutes) were used to study the effects on germination, in petri dish and in substrate as well as on the surface contamination in vitro conditions. Analysis of the water uptake has been carried out by different methodologies for the plasma treated seeds compared with dried ones: exposure to water vapor, immersion in liquid water and monitoring on a microbalance in presence of humid environment. Furthermore, the content of peroxo-type species incorporated in the seeds after their plasma treatment was evaluated in order to support the central hypothesis of this work: the fact that peroxo-type species can affect abscisic acid (ABA), an agent responsible for the seed dormancy and, consequently, in the germination rate. Chemical and morphological changes in the treated barley seeds were studied with techniques such as Scanning electron microscopy (SEM), Energy Dispersive X-Ray Spectroscopy (EDX) or X-ray photoelectron spectroscopy (XPS). The results indicate an increase in germination rate and decrease in contamination level upon plasma treatment without a correlated increase in the water uptake capacity. By contrast, the formation of reactive oxygen and nitrogen species (ROS and RONS) can affect the ABA factor and enhance the germination rate of barley seeds (Figure 1). for an oral or poster presentation.

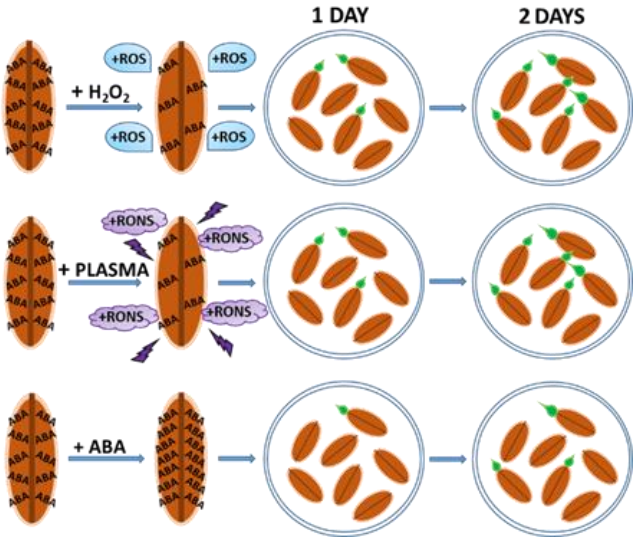

Fig. 1. Scheme showing the effect of H_2O_2 and plasma treatments in the generation of RONS and the affectation of ABA as responsible for the acceleration of the germination rate. From left to right: the removal of ABA molecules after the incorporation of RONS species produce a decrease in the concentration of ABA within the seeds and the triggering of germination evidenced by an increase of the germination rate

2. References

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