DBD plasma treatment of seeds for improved germination and early stage growth

C. Constantin[1,2], C. Stancu[1], V. Satulu[1], L.G. Carpen (Coman) [1], C. Chireceanu[3], G. Dinescu[1], B. Mitu[1]
[1]*National Institute for Laser, Plasma and Radiation Physics, 409 Atomistilor str., Magurele -Ilfov, 077125, Romania*
[2]*Faculty of Physics, University of Bucharest, 405 Atomistilor str., Magurele -Ilfov, 077125, Romania*
[3]*R&D Institute for Plant Protection, Ion Ionescu de la Brad 8, Bucharest, 013813, Romania*

Abstract: The present contribution reports on the experiments performed by using various DBD discharge configurations operating at atmospheric pressure for treatment of bean seeds of several varieties (Phaseolus vulgaris L.). The results point out the parametric windows of the plasma treatment under which the seed germination rate and plant growth improve, while evidencing that beans variety is also important.

1. Introduction

Plasma agriculture is an emerging research field due to the enhanced crop productivity and environmentally friendly character. In particular, cold plasma treatment has emerged as a promising technique to enhance seed germination and plant growth [1]. The efficacy of plasma treatments varies depending on factors such as the type of plasma source, treatment duration, and seed species or varieties.

As such, in the present work we involved several DBD plasma sources operating at atmospheric pressure to treat bean seeds of several varieties (Phaseolus vulgaris L.) on the way to upscale the treatment to large scale.

2. Methods

A preliminary study was conducted using a singular filamentary plasma jet with axial symmetry operating in Ar admixed with reactive gases (O_2, N_2) at power in the range from 70 – 120 W [2]. Secondly, we have performed treatments by using a scaled -up plasma source of 70 cm length, consisting of 140 plasma jets supplied from the same RF generator under a power of 150 W and same mass flow controller MFC set on 10000sccm, while the beans remained static. Finally, a linear DBD plasma jet of 10 cm width was involved in plasma treatment at 100 W and 3000sccm, under a continuous movement of both plasma source and the beans. The effects of the plasma treatment on the chemical and morphological aspect of the beans, as well as on the germination rate and early growth of plants were investigated.

3. Results and Discussion

The results indicate the modification of wettability upon treatment, the water contact angle decreasing from 80 – 90° for the untreated beans to 20 – 38° for the plasma treated ones, being higher for the mottle beans and lowest for the black beans. The SEM investigations on the beans show a decrease of the seed coat and an increase of the surface roughness, as well as the apparition of microcracks upon plasma treatment, that might be all responsible for the better water uptake.

For the single filamentary jet, the germination rates were significantly higher for the plasma treated samples for the power ranging from 70 – 110 W, decreasing with respect to control sample. For the multiple jet plasma, the length

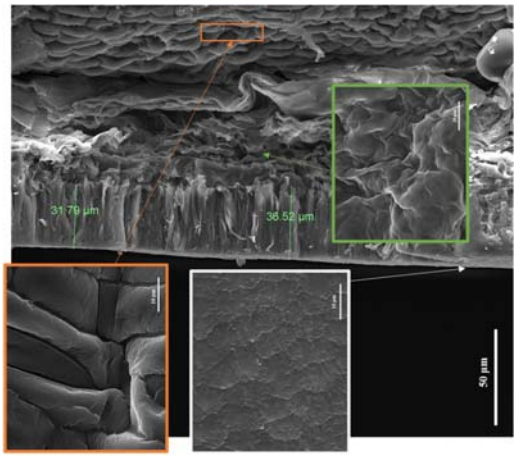

Fig. 1. Morphological evaluation of the beans upon DBD plasma treatment

of plants originating from the plasma treated seeds is significantly higher than those from control seeds, with some plants exceeding 60 cm after 22 days from seeding. Significant differences were encountered among the plants grown for seeds treated in linear DBD discharge, that evidenced longer plants with lighter roots for intermediate exposure times as compared to the shorter plants with heavier roots for the seeds exposed longer to the plasma.

4. Conclusion

DBD plasma treatment of bean seeds has proved an effective method for enhancing the germination rate and plant early growth, for all the investigated plasma configuration, if moderate power and exposures are used.

Acknowledgement
This work was financed by the Romanian Ministry of Education and Research, within the program LAPLAS VII–contract no. 30 N/2023 and the Ministry of Agriculture and Rural Development, project no. ADER 2.1.7/2023.

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