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BOOK OF ABSTRACTS

PLASMA ACTIVATED WATER AND AMMONIA SOLUTIONS TESTED AS FERTILIZERS

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As envisioned by Graves et al. [1], improved utilization of organic waste for fertilizer has significant worldwide economic and ecological potential, which can be unlocked using plasma. Most animal types of organic fertilizer (manure, urine) contain ammonia, which is released into the environment and significantly contributes to the global warming. Atmospheric air plasmas enable very efficient nitrogen fixation into nitrogen oxides or into water [2-3]. Plasma activation of organic fertilizer offers the possibility to increase the nitrogen content and reduce the loss of greenhouse ammonia by converting it into less volatile but more fertilizing ammonium nitrate. In addition, plasma activation reduces odour and controls the bacterial population of the organic fertilizer mixture [1].

Plasma activated water (PAW) is formed by exposure of water to the cold plasma resulting in the production of reactive oxygen and nitrogen species (RONS, e.g. H_2O_2, NO_2^-, NO_3^-, $ONOO^-$, OH radicals) [4-5]. PAWs produced by different plasma sources and with various chemical compositions have been demonstrated to have effects on the improved seed germination and bacterial/fungal decontamination, and as nitrogen fertilizer they can enhance the plant growth [5-6].

We test various types of PAWs and ammonia solutions (up to 4 mM), activated by atmospheric air plasmas of the transient spark discharge with water electrospray or circulating water, and DC glow discharge with water cathode. The chemical composition of each PAW or plasma activated ammonia solution (PAA) is characterized by measuring pH and long-lived RONS concentrations (H_2O_2, NO_2^-, NO_3^-) by UV/VIS absorption spectroscopy. PAW only or PAW/PAA effects on wheat (*Triticum aestivum L.*), barley (*Hordeum vulgare L.*), and radish (*Raphanus sativus*) plant growth enhancement were investigated. After 4-12 weeks of plant growth, the effects of PAWs/PAAs watering on seedlings or adult plants were analysed by measuring growth parameters (above ground plant length, fresh and dry weight) and several physiological parameters, e.g. content of photosynthetic pigments, rate of photosynthesis and antioxidant enzymes activity.

The results showed that PAWs generated by various atmospheric air plasma discharges have the potential to improve the plant growth and increase the photosynthetic pigments concentration and other physiological plant parameters, without causing any genetic modification. The preliminary results with ammonia solutions suggest that ammonia as a source of nitrogen slightly improves the plant growth. PAAs farther enhance the plant growth, depending on the type of plasma activation (i.e. H_2O_2, NO_2^-, NO_3^- concentrations). The encouraging results with PAAs, i.e. chemically simplified experimental model of the plasma activated organic fertilizer represent the initial laboratory study as input data for future testing and up-scaling of plasma activation of real organic fertilizers.

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