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# PLASMA APPLICATION TO SEED AS GERMINATION AND GROWTH ENHANCER

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Plasma is known as the fourth state of matter after solid, liquid, gas and it is distinguished with several properties like temperature (hot and cold plasma), fluid flow quality due to miscellaneous modules of plasma and particle nature (e.g. electron, neutron, ions ) and as a substrate under the influence of external magnetic and electric fields. In earlier researches, plasma was used as an appropriate method for the decontamination of food and prevents food spoilage for food safety but now a day's scientist is working on the application of plasma for seed quality enhancement, sterilization of seed for storage and control the pest and pathogens in storage condition. It was reported by many scientists that plasma treatment for a few minutes or even seconds improves germination, seedling growth, vigour and biochemical properties of subjected seeds. Plasma tends to interfere with the cell membrane, and changes some of its core quality, resulted in high seed quality.

Plasma considered as substance having elevated energy with charged particle and reactive oxygen species which modify the outer surface as well as internal processes of seed after exposure. Plasma alters seed coat properties and makes it more permeable for water imbibition which stimulates hydrolytic enzyme activities, transfer of energy in the form of stored food material from endosperm to embryo which causes quick germination and seedling growth. High metabolic activity of germinating seed under the influence of plasma treatment may be due to the generation of reactive oxygen species. It increases the activity of superoxide dismutase and nitrate reductase, which protects the plant at the time of various stress conditions. Plasma widely used for sterilization and destruction of microflora occurrence on the surface of plant seed. In the case of plasma exposure, intensity and duration play a greater role since too low intensity may not affect the speed up to a level of significant changes while too strong intensity may have a detrimental impact on seedling growth. Numerous studies have shown that plasma enhances the wettability of seeds through

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modification in seed coat structure due to the collision of ions and reactive oxygen species generated through plasma.

## Role of Plasma in Improvement of Germination

Plasma treated seeds germinate faster and uniformly in comparison to untreated seeds; however, the performance of seed largely depends on dose and duration of plasma exposure. Every crop responds in a dissimilar manner on the exposure of plasma in terms of germination, growth and yield. Under favourable as well as abiotic stress condition plasma treated seeds show improved germination rate. The prime reason behind this betterment may be due to higher water absorptive capacity of treated seeds in comparison to untreated seeds. Plasma exposure modifies seed surface characteristics and leads to higher hydrophilicity and water uptake. Quick and rapid water absorption promotes germination under supporting and antagonistic farm situation too. It was reported that seeds of cotton treated with cold plasma using argon gas for the duration of 3 and 27 minutes resulted in higher water absorption and germination percentage over untreated seeds (Groot *et al.*, 2018). Reports of higher germination due to plasma treatment are reported in many crops included wheat, rice, sunflower, chickpea.

## Role of Plasma in Improvement of Seedling Growth

Apart from enhancing germination rate, plasma exposure boosts sprout length, dry mass of sprout and vigour of seedling, which also gives seed an upper hand under lack of resources or stressed conditions. Due to the alteration in cell wall property of seed surface, water absorption increase through seeds which leads to a quick breakdown of a food reserve, rapid germination and extension of radicle and plumule. Through the plasma treatment, both hydrophobic and hydrophilic thin layers of seed get exposed and observe various changes. These changes help the seed in different cultivation conditions. In wet soil, hydrophobic layers delay water uptake while hydrophilicity gives rise to the higher moisture uptake and stimulate germination at a quick rate under dry conditions. They indicated that the composition of gases in plasma treatment does not bring change in the genome structure of seed but modify seed surface characteristics, catalyze enzymes activities of germinating seeds. The soluble protein content, sugar content and dehydrogenase enzyme activity of seeds get modified due to plasma exposure. Reoriented enzymes improve the growth of radicle and plumule, reactive oxygen species emitted during plasma treatment enhance the metabolic

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activity, scavenge damage due to stress condition and boost growth parameters (Randeniya and Groot, 2015).

## Role of Plasma in Improvement of Seed Biochemical Activities

Due to plasma treatment, stimulation in enzyme activities inside the seed occurs, which includes the higher activity of α amylase, protease and dehydrogenase etc. These enzymes are known as core hydrolytic enzyme and take part in the breakdown of food material stored in endosperm. This breakdown supplies energy to the embryo and initiates germination. Apart from this, seed surface got softer due to oxidation, and plasma gasses interaction with micro-molecules of seed and reactive species perforated though seed coat easily and alter the biochemical activity of seed. Increment in enzyme activity was reported in case of moong seeds after the application of plasma in comparison to control(Sadhu *et al.*, 2017). This increase encourages higher and speedy germination under both favourable as well as the adverse situation.

## Role of Plasma in emergence and establishment of crop

Apart from performing better under the controlled condition of laboratory, plasma-treated seeds show superior results in farm condition as well over untreated seeds. Results collected from various laboratory studies confirm higher uptake of water, advanced enzymatic activity and improved germination in plasma treated seeds which also indicate improved results in the field too. Numerous researches show that pre-sowing plasma treatment to seed resulted in uniform crop stand, better growth and yield of various cereals, pulses and oilseed crops. Wheat yield of plasma-treated seed increased 5.89% higher than control while growth parameters including plant height, root length, leaf area and fresh weight were also recorded higher over untreated seeds (Jiafeng*et al.*, 2014).

## Conclusion

Plasma is one of the most advanced and modernized seed treatments for a strengthening of seed and parallel to this; it enhances the quality of seed. However, intensity and duration of plasma exposure to the different crop seeds need to standardize for optimum results. Low power plasma may not affect the seed germination and growth while too strong plasma may also have a detrimental effect on seedling growth, but optimum strength

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significantly influences germination and seedling vigour indices. This technique has the potential to change the crop growth scenario, which needs to be exploring for future vision.

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