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Investigations on Cold Atmospheric Plasma Jet for Plant Mutation

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Cold atmospheric plasmas (CAPs) have received increasingly attention because of their promising applications in various emerging novel fields, including agriculture, medicine, nano-scale materials synthesis, etc. The emergence and rapid development of the CAP applications in agriculture – "Plasma Agriculture" [1], makes it widely acknowledged that the CAPs have a great potential as an efficient green tool for plant growth promotion and plant disease control. Preceding studies have shown that after either CAP direct or indirect treatment of seeds or plant tissues under appropriate conditions, the seed germination, growth yield, as well as tolerance to disease infection, can be significantly improved. The abundant chemically reactive species in CAPs, especially the reactive oxygen species (ROS) and reactive nitrogen species (RNS), are believed to play a significant role.

Up to now, most studies in plasma agriculture have been actively conducted mainly focusing on the activation of plant seeds and tissues or disinfection of plant pathogens. Little attention has been paid to the plant mutagenesis. The CAP jet produced using a co-axial-type plasma generator with a bare-metallic electrode configuration and driven by a radio-frequency (RF) power supply [2] has been proved to be effective for genome mutation of micro-organisms. Therefore, it is anticipated to achieve the genome mutation for plants by using the similar RF CAP jet.

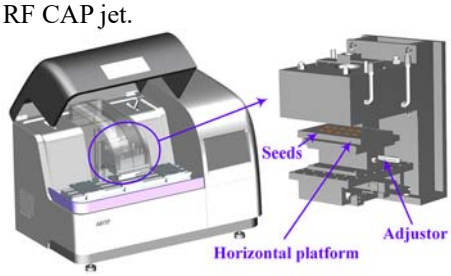
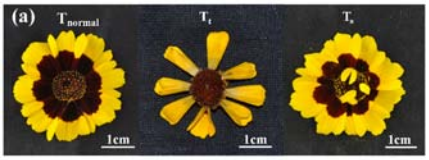


Fig. 1 Picture of the novel mutagenesis machine for the treatment of plant seeds.

In this work, a novel RF CAP jet generator for plant mutagenesis is designed, which can generate helium plasma jet with large discharge area, low gas temperature, high electron energy and high concentrations of chemically reactive species. The electrical, thermal and optical measurements show that the RF discharges are stable and uniform. Then, a highly integrated mutagenesis machine (the so-called ARTP-P machine) with the RF CAP jet generator as the core part is developed for genome mutation of plant seeds (Fig. 1).

To further prove the homogeneity of the biological effect after plasma treatment, the mortality tests of *Escherichia coli* are conducted. And the results show that the RF CAP jet treatment has a homogeneous effect. What's more, a typical example for the treatment of the *Coreopsis tinctoria* Nutt. seeds is conducted. The experimental results show that, after treatment using the ARTP-P machine, not only the seed germination potential and rate are improved, but also the flower appearances are remarkably changed (Fig. 2). This proves that RF CAP jet treatment leads to heritable changes in the gene sequence which governs the flower appearances.



(b)

	Number of tested plants	Number of T_{normal}	Number of T_t	Number of T_v
Control	45	45	0	0
T_0	45	39	3	3
T_1	40	10	12	18
T_2	40	11	10	19

Fig. 2 Mutation results of *Coreopsis. tinctoria* Nutt. after treated by the ARTP-P machine. (a) Flower appearances; (b) Number of each appearance in different generations.

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