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水中放電を用いた水耕栽培溶液中の植物病害菌失活化
Inactivation of Plant Pathogenic Bacteria Using Discharge Plasma under Liquid Fertilizer in Hydroponic Culture System

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1. Introduction

The discharge plasma produces chemically active species such as ozone and hydroxyl radicals. These chemical species play an important role in inactivating various pathogenic bacteria in liquid fertilizer. Thus, a discharge plasma under water has attracted attention and is a promising technique to reduce infection risks. A gas-liquid phase discharge plasma reactor was developed using a magnetic pulse compression (MPC) pulsed power generator, and its performance for inactivating bacterium of the liquid fertilizer was evaluated using *Ralstonia solanacearum*, a plant pathogenic bacterium, and tomato seedlings.

2. Experimental

The reactor consisted of a wire electrode which was placed in an insulating circular cylinder, and a grounded electrode on cylinder outside. The distance between wire electrode and gas-liquid phase was approximately 10 mm. The reactor was sunk under the liquid fertilizer. Atmospheric air was injected into the cylinder using a gas pump and released through holes. Repetitive nanosecond pulses are applied to the wire electrode, using MPC pulsed power generator. Peak voltage was approximately 10 kV. Pulse width and repetition rate was 150 ns and 2,000 pulse per second (pps), respectively. The performance of the developed reactor on inactivation of bacteria was evaluated in hydroponic culture system using the discharge plasma system as shown in Figure 1. The liquid fertilizer was contaminated with *Ralstonia solanacearum*, a plant pathogenic bacterium, after 40 min of discharge plasma treatment. After that, discharge plasma treatment was continued for 100 min. Plant was tomato seedlings. Number of seedling was 15. Volume of the liquid fertilizer was approximately 15 L. Seedlings were monitored and disease severity was evaluated.

3. Results

Figure 2 shows the disease severity of seedlings. The disease severity was zero for the seedlings in negative control for 10 days. The disease severity in discharge plasma treatment increased on the 6th day and was 20 % on the 8th day and after. In contrast, the disease severity of positive control increased on the 4th day and continuously increasing to be 100 % on the 8th day. Disease severity of seedlings were suppressed by discharge plasma treatment.

4. Conclusion

We developed a discharge plasma reactor under liquid fertilizer for inactivating bacteria in hydroponic culture system of hydroponics, and evaluated the performance of the developed reactor using tomato seedlings in a hydroponics. Disease severity of seedlings in positive control was 100 %, but that with discharge plasma treatment was suppressed to be 20 % on the 8th day and after. It can be concluded that the bacterial wilt disease is significantly suppressed by the developed reactor.

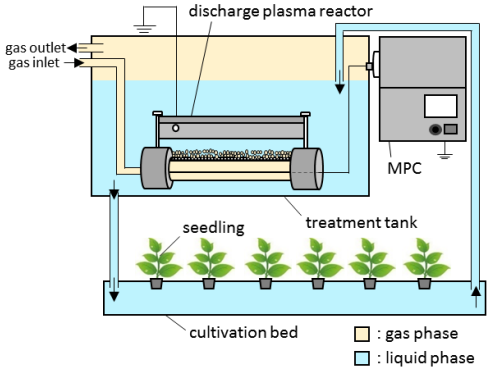

Fig. 1. Schematic of the discharge plasma reactor in the hydroponic culture system of hydroponics.

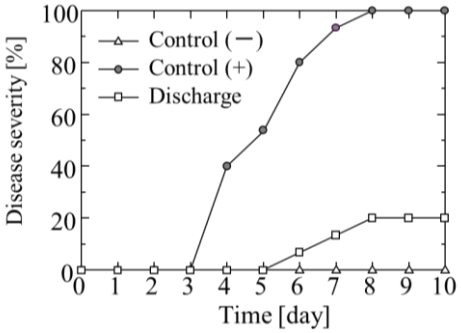

Fig. 2. Disease severity of seedlings in experimental sections of Control (−): negative and Control (+): positive control, and Discharge: discharge plasma treatment. Disease severity was obtained using the equation as follows: Disease severity = 100 x (4A+3B+2C+D)/4N, where A, B, C, and D are the numbers of tomato seedlings with <10%, 10-33%, 33-67% and >67% infected stumps, respectively, and N is the total number of seedlings examined.

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