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Improvement of growth and yield of rice plants with plasma treatment

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Various application of non-equilibrium atmospheric-pressure plasma (NEAPP) in agriculture has much attentions. The growth enhancement with plasma treatment have been reported for various plant species, such as radish [1], *Arabidopsis thaliana* [2], and barley [3]. Plant growth consists of multiple steps, such as seeds, seedlings, flowerings, and harvest. For the agricultural applications, various uses can be expected such as growth enhancement, increase of yields, and inactivation of pathogenic microorganisms. In our group, we previously developed the ultrahigh electron-density plasma source [4,5], and applied for the inactivation of *Penicillium digitatum* spores[6,7] and selective killing of cancer cells.[8] Besides, we recently developed the plasma-activated Ringer's lactate solution (PAL), by which brain tumor cells were induced to apoptotic death.[9] In this study, concerning the multi-steps of the rice plant growth, we treated the cold plasma with the rice the seeds and seedlings of rice, and investigated the effects on the growth and yield.

Rice seeds were immersed in distilled water at 4°C overnight. Then, the seeds were set at 10 mm below from the nozzle of the plasma source, and treated them for 5, or 10 s with the ultrahigh electron-density plasma source. The seeds were immersed in distilled water after the plasma treatment and incubated in the dark at 30°C for 2 days. And then, we measured the length of coleoptile for the growth check after the germination as shown in Fig. 1. The coleoptiles of plasma-treated seeds significantly became +80% and +87% longer than those from control seeds, respectively. The results indicated that the plasma treatment of rice seeds promoted the growth after germination. We will report the results in detail including the later growth.

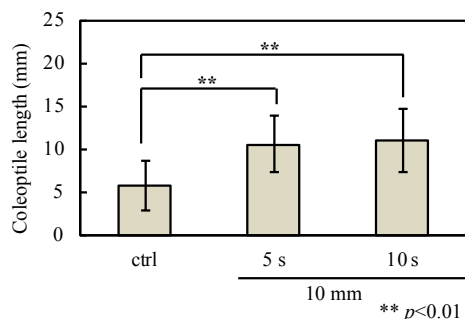


Fig. 1. Length of coleoptiles treated with plasma

Besides, we conducted the test in the outer field. After the transplant of rice seedlings in the university paddy field, the plants were treated by plasma twice a week. We

treated young rice plants by direct irradiation for 30 s and 5 min, or PAL treatment by the immersion with the diluted solution to 25-, 100-, 250- and 1000-folds. All treatment periods until the heading (~2 months) were further divided into “Early” and “Late”. Figure 2 shows the weight of total panicles from harvested plants. The weight from plants treated with direct irradiation during early period was relatively higher than control ones. On the other hand, those during all and late periods were same or less, respectively. The result suggests that the treatment during early period is effective. The PAL treatment showed no positive effect at low concentrations and negative effect at high concentrations. We will report other results and discuss them in detail.

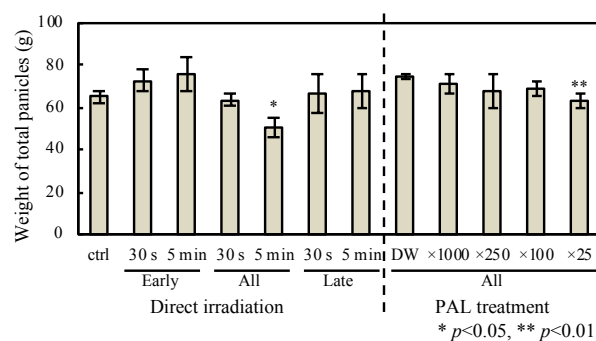


Fig. 2. Weight of total panicles from harvested plants.

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References

- [1] S. Kitazaki, et al., *Curr. Appl. Phys.*, **14**, S149 (2014).
- [2] K. Koga, et al., *Appl. Phys. Express*, **9**, 016201 (2016).
- [3] Y. Park., et al., *Plasma Process. Polym.*, **15**, e1600056-1:8 (2016)
- [4] M. Iwasaki, et al., *Appl. Phys. Lett.*, **92**, 081503 (2008).
- [5] H. Inui, et al., *Appl. Phys. Express*, **3**, 126101 (2010).
- [6] S. Iseki, et al., *Appl. Phys Lett.*, **96**, 153704 (2010).
- [7] H. Hashizume et al., *Appl. Phys Lett.*, **103**, 153708 (2013).
- [8] S. Iseki et al., *Appl. Phys Lett.*, **100**, 113702 (2012).
- [9] H. Tanaka et al., *Sci. Rep.*, **6**, 36282 (2016).