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Impact of plasma irradiation on plant seeds metabolism

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Effects of plasma irradiation on seed response has garnered considerable attention [1], particularly for its role in enhancing germination and overall growth stages [2-5]. Recently, molecular biological studies have revealed plasma irradiation enhances germination and these responses correlated with a decrease in abscisic acid (ABA) and an increase in gibberellin (GA) content [6, 7]. Additionally, plasma irradiation increases in GA content and induces long-lasting effects on leaf gene expression and stimulates the expression of proteins primarily involved in photosynthetic processes and their regulation [8]. Thus, plasma irradiation to seeds affects their metabolisms and induces phenotypes and omics responses.

The gene-level studies of plasma irradiation to seeds have shed light on some of the mechanisms underlying such effects [1]. Plasma-irradiated seeds show improvement of germination characteristics, and downregulation of genes involved in ABA biosynthesis, whereas upregulation of genes involved in ABA catabolism and α-amylase biosynthesis [9]. Further, plasma irradiation caused significant hypermethylation of the NCED5 promoter and hypomethylation of Amy1C and Amy3E promoters, which matched their expression patterns. These results show that plasma irradiation to seeds allows us to regulate epigenetics, altering DNA methylation (Fig. 1).

It is important to be conducted the quantitative evaluation of the number of plasma-induced particles (Reactive oxygen and nitrogen species (RONS), photons, ions, etc.) supplied into the seeds to understand the mechanism of plasma irradiation effects. Mass spectrometry provided experimental evidence that nitrate ion, NO_3^-, is introduced in seeds as RONS upon irradiation with plasma [10]. NO_3^- in plant seeds is responsible for inducing responses such as dormancy break, gene expression regulation, signal transduction, and ABA metabolism resulting from NLP8 binding to the *CYP707A2* promoter. In the future, we will quantitatively investigate the biological responses based on the physical quantities of factors that plasma irradiation exerts on seeds.

In the presentation, we will discuss the research from the viewpoint of plant metabolism, including the latest results.

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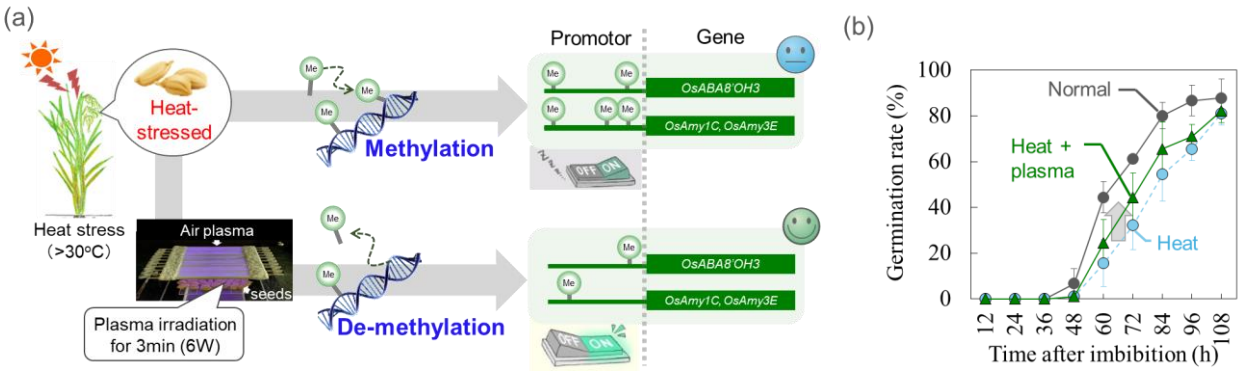

Fig. 1. (a) Conceptual diagram of DNA methylation alteration in promotor of gemination-related genes of rice seeds by plasma irradiation and (b) recovery of degraded germination characteristics of heat-stressed seeds by plasma irradiation.