Enhancement of drought tolerance in soybean plants by down-regulation of *GmERA1* genes

Drought is one of the biggest issues affecting global soybean production. A lot of drought tolerance-related genes have been identified in model plants such as *Arabidopsis thaliana*. Functional validation of candidate genes could provide gene resources for breeding varieties of non-model staple crops, such as soybean, that can withstand drought conditions. Previous research has implicated that farnesyltransferase gene *ERA1* in *A. thaliana* is one of promising candidates for genetic manipulation of drought stress tolerance. Although *ERA1* homologs in soybean plants (*GmERA1*) could be a candidate for improving drought tolerance, the function of *GmERA1* had been unrevealed. As soybean is recalcitrant to transformation and gene expression analysis, we employed a virus vector system to validate the potential candidate gene *GmERA1* for drought resistance in soybean.

A plant virus vector derived from *Apple latent spherical virus* (ALSV) was used for the functional analysis of *GmERA1* in soybean plants. Soybean leaves subjected to ALSV-mediated *GmERA1*-down-regulation showed increased drought stress responses with reduced water loss, gas exchanges and higher leaf surface temperature (Fig. 1). *GmERA1*-down-regulated soybean plants also showed reduced wilting and higher survival rate under water-limiting conditions compared to control plants (Fig. 2).

Our data support the proposal that *GmERA1* can be downregulated to increase drought tolerance in soybean. We also demonstrate that the virus vector system, which bypasses the need to generate transgenic plants, is a useful tool for evaluating candidate drought-resistance genes in soybean in the short term.

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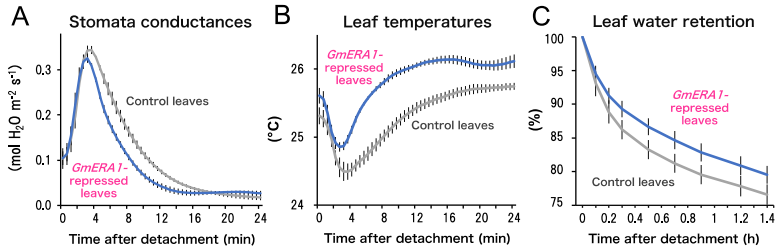

Fig. 1. Improved drought stress responses in *GmERA1*-repressed soybean leaves
Leaf detachment-induced response of stomatal conductance (A), leaf temperature (B), and water retention (C) in soybean leaves infected with *GmERA1*-recombinant virus were measured. Data are means ± SE (n = 3 to 6). Figures are modified from Ogata et al. (2017).

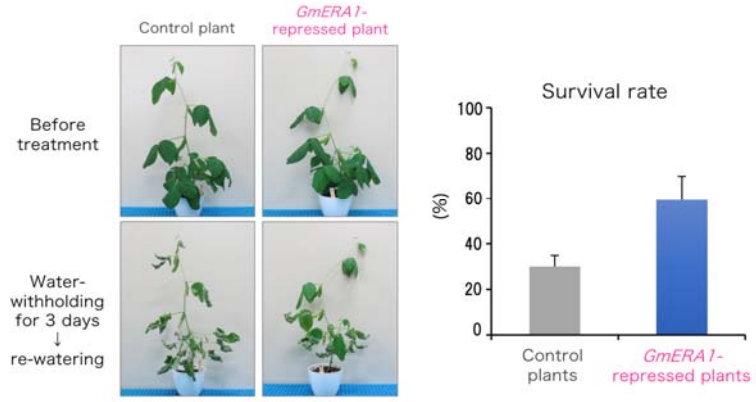

Fig. 2. Improved drought tolerance in *GmERA1*-repressed soybean plants
The soybean plants infected with *GmERA1*-recombinant virus were withheld water for three days before re-watering (left panels). Survival rate of the plants were recorded after re-watering (right panel). Data are means ± SE (n = 3 to 6). Figures are modified from Ogata et al. (2017).

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