Identification of Novel Drought-Resistant Genes From Gene-Environment Association in Arabidopsis thaliana

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Drought is one of the prime environmental constraints for plant growth and productivity in the world. While plant stress is usually controlled by multiple factors, conventional investigations are often restricted to a single trait. Under such circumstances, directly identifying genetic variation associated with environmental factors may be a more convincing and powerful method for investigating multiple or complex traits related to stress. We performed Genome-wide association study (GWAS) based on the environmental data of the Iberian Peninsula, which contains high genetic and environmental variability. We identified the candidate genes AT1G58310 and AT4G32040, which are highly correlated with precipitation and drought. Further analyses showed that while both candidate alleles co-exist in other parts of Europe, but segregate differently according to their drought conditions in the Iberian Peninsula. Moreover, we performed experiments with candidate gene mutants and treat them with drought stress with polyethylene glycol. The results showed that the root system of the mutant plants was significantly longer and wider than wild type, especially under drought stress, indicating that AT4G32040 plays a key role in Arabidopsis thaliana root development, likely associated with the response to drought stress. Using the unique combination of evolutionary ecology, genetics, and phenotypic observation, we discovered novel drought-resistant genes. Our approach might contribute to the improvement of drought tolerance and water use efficiency of crops to combat water scarcity and increasing demand for food production in the foreseeable future.

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