

Genetically-determined variations in photosynthesis indicate roles for specific fatty acid species in chilling responses

Donghee Hoh¹, Patrick Horn², Atsuko Kanazawa¹, John E. Froehlich¹, Jeffrey Cruz³, Oliver Tessmer¹, David Hall¹, Lina Yin⁴, Christoph Benning¹, and David M. Kramer³

¹Michigan State University

²East Carolina University

³MSU-DOE Plant Research Laboratory

⁴Northwest A&F University

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Abstract

Using a population of recombinant inbred lines (RILs) cowpea (*Vigna unguiculata*. L. Walp), we tested for co-linkages between lipid contents and chilling responses of photosynthesis. Under low temperature conditions (19°C/13°C, day/night), we observed co-linkages between quantitative trait loci (QTL) intervals for photosynthetic light reactions and specific fatty acids, most strikingly, the thylakoid-specific fatty acid 16:1 $\Delta^{3\zeta\rho\alpha\nu\varsigma}$ found exclusively in phosphatidylglycerol (PG 16:1t). By contrast, we did not observe co-associations with bulk polyunsaturated fatty acids or high-melting-point-PG (sum of PG 16:0, PG 18:0 PG 16:1t) previously thought to be involved in chilling sensitivity. These results suggest that in cowpea, chilling sensitivity is modulated by specific lipid interactions rather than bulk properties. We were able to recapitulate the predicted impact of PG 16:1t levels on photosynthetic responses at low temperature using mutants and transgenic Arabidopsis lines. Because PG 16:1t synthesis requires the activity of peroxiredoxin-Q, which is activated by H₂O₂ and known to be involved in redox signaling, we hypothesize that the accumulation of PG 16:1t occurs as a result of upstream effects on photosynthesis that alter redox status and production of reactive oxygen species.

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