HIGHER PROPORTIONS OF UNSATURATED FATTY ACIDS IN SEEDS IMPROVE COLD GERMINATION ABILITY IN UPLAND COTTON (*GOSSYPIUM HIRSUTUM*) MUTANTS

Lakhvir Kaur
Junghyun Shim
Benildo G de los Reyes
Rosalyn B Angeles-Shim
Texas Tech University
Lubbock, Texas

Abstract

Seed germination is a critical stage in the life cycle of a plant and is divided into three phases based on water uptake. Phase I is defined by a rapid water imbibition that plateaus during phase II. Phase III is characterized by an upturn in water uptake as the emerging radicle starts absorbing water. The influx of water in phase I triggers cell membrane reorganization from a leaky hexagonal II to a semi-permeable lamellar configuration. During this transition, leakage of solutes is commonly observed but at low temperatures, cell membranes lose flexibility, exacerbating cytoplasmic leakage which can lead to seed metabolic dysfunction and even embryo death. Unsaturated fatty acids having carbon chains linked by one or more double bonds prevent close packing of membrane lipids under cold conditions, providing the membrane more flexibility. In this study, four fatty acid (FA) mutants with different FA profiles, along with three conventional cultivars, were evaluated at 12°C (critically low), 15°C (cardinal minimum) and 30°C (optimum temperature) for germination performance, electrolyte leakage and water uptake patterns. FA mutants with higher unsaturation/saturation ratios registered robust germination, lower solute leakage and optimum water uptake at 12°C. Seeds with higher unsaturation/saturation ratios but lower polyunsaturation: saturation ratios showed lower solute leakage and rapid water imbibition but poor germination due to the preferred metabolization of polyunsaturated FAs at lower temperatures. The conventional cultivars with lower unsaturation/saturation ratios recorded higher solute leakage, slower imbibition and poor germination under cold stress. At 30°C, significant differences in cold response parameters were not observed across genotypes. Imbibition at 30°C for 8 hours before cold exposure facilitated as high as 1400% improvement in the germination of the cold sensitive genotypes, indicating that the first few hours of imbibition involving the process of membrane reorganization are critical for cold germination.