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Ruojing Wang

Canadian Food Inspection Agency, Canada

Yuguang Bai

University of Saskatchewan, Canada

Edward J. Kendall

University of Saskatchewan, Canada

Karen Tanino

University of Saskatchewan, Canada

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Profile of water uptake in winterfat during seed germination

Ruojing Wang¹, Yuguang Bai², Edward J. Kendall³ and Karen Tanino²

¹Canadian Food Inspection Agency, 301-421 Downey Road, Saskatoon, SK S7N 4L8 ²Dept of Plant Sciences, Univ. of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8, Canada ³Dept of Biochemistry, Univ. of Saskatchewan, 107 Wiggins Rd., Saskatoon SK S7N 5E5, Canada

Key words aquaporin inhibition, Chenopodiaceae, germination, HgCl₂, NMR spectroscopy, Saskatchewan, water relations, winterfat (*Krascheninnikovia lanata*)

Introduction Aquaporins are enriched in zones of fast cell growth, expansion and vacuolization (Ludevid et al., 1992; Schäffner, 1998). These observations suggest that aquaporins are involved in cell elongation and growth, osmotic regulation and resistance to drought and salinity stress (reviewed in Schäffner, 1998; Johansson et al., 2000). We examined: (1) the role of aquaporins in seed water relations during seed imbibition and early seedling growth of winterfat at low temperatures; and (2) water distribution and biophysical status within a germinating seed.

Materials and methods Five replicates of twenty seeds (total 100 seeds) were imbibed at 5°C in darkness. 2.5 mL of 0, 30, 35, 40, 50 and 100 (M HgCl₂ (aquaporin inhibitor, Sigma, USA) was used. NMR spectroscopy: Bruker Advance DRX 360 WB system (Bruker BioSpin Ltd., Milton, ON, Canada), at 360.13 MHz. ¹H microimaging was performed at 20°C on a single seed mounted in a shortened pipette tip inserted into a plexiglass foot and then placed in a 10 mm NMR tube. Spin-lattice relaxation rates, R₁ (1/T₁), and spin-spin relaxation rate, R₂ (1/T₂), were also measured at each interval.

Results Water migrated first to the embryo then to the perisperm (Figure 1). Exposure to HgCl₂ significantly restricted water flux to the perisperm, which was also associated with reduced germination rate (Figure 1). Both embryo and whole seed water uptake was reduced in the presence of 30 M HgCl₂, a dose lower than the LD₅₀. The impact of restricted water uptake was expressed preferentially in the root during early seedling growth, which was 24 times shorter in the presence of mercury, indicating more dry matter allocation to the cotyledons. Results suggest that aquaporins mediate seed water relations from initial seed imbibition to early seedling growth.

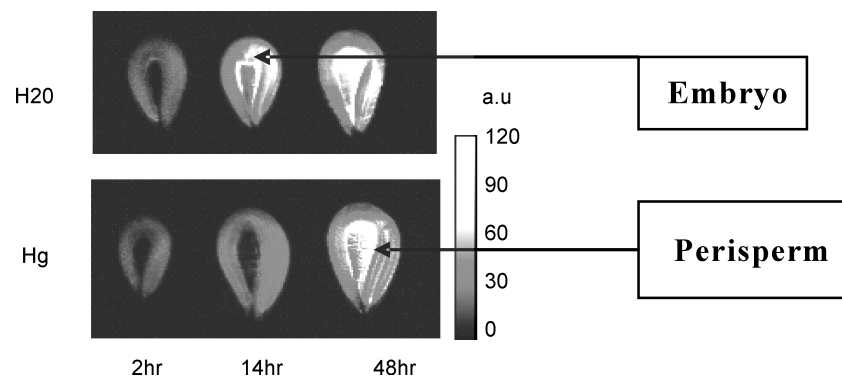


Figure 1 NMR microimaging of winterfat seeds during imbibition at 20°C with and without 30 M HgCl₂. Scale indicates range from no measurable free water (0, black) to maximum limit of measurable free water (120, light yellow).

Conclusions In winterfat, aquaporins were determined to play a critical role in germinative and early-growth water dynamics. Water entered the embryo in early water uptake and then diffused mainly through cell to cell pathways to the perisperm, reaching the maximum content near embryo protrusion in winterfat.

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