Is recruitment of SUMOylation the answer to climate resilience and increased crop yield?

Le Roux ML, Botha A-M, Kunert K and Cullis CA.

Post-translational modifications of proteins play a critical role in cellular signalling processes. In recent years, the SUMO (Small Ubiquitin-like Modifier) class of molecules has emerged as an influential mechanism for target protein management. SUMO proteases play a vital role in regulating pathway flux and are therefore ideal targets for manipulating stress-responsive SUMOylation. It was shown that SUMOylation could be recruited to dramatically improve plant growth during salinity stress, drought and high temperature stress by overexpressing the SUMO protease gene *OTS1* in Arabidopsis. Recently we identified and cloned wheat homologs of *OTS1*, *OTS2* and *ICE*, suggesting that SUMOlytion may also be important in other crops. Thus, we transformed wheat lines with *OTS1* to enhance stress resilience. In a parallel approach, ethylmethanesulfonate (EMS) and Sodium Azide mutagenic lines were also developed, selected for water stress tolerance, and the mutagenic progeny tested for their stress responses. We also sampled wheatgrass, *Thinopyrum distichum* (2n = 4x = 28; J1dJ1dJ2dJ2d), a hardy, salt-tolerant maritime wheatgrass indigenous to southern Africa to compare its responses and genetic composition to that of our transgenic and mutagenic lines. To elucidate the possible contribution of SUMOylation to the increased drought tolerance observed in these lines, they are screened for SUMO targets. Data on observed yield increases, delayed water loss and senescence, changes in chlorophyll content, protein profiling, enzymatic activity, well as genotypic differences will be presented.

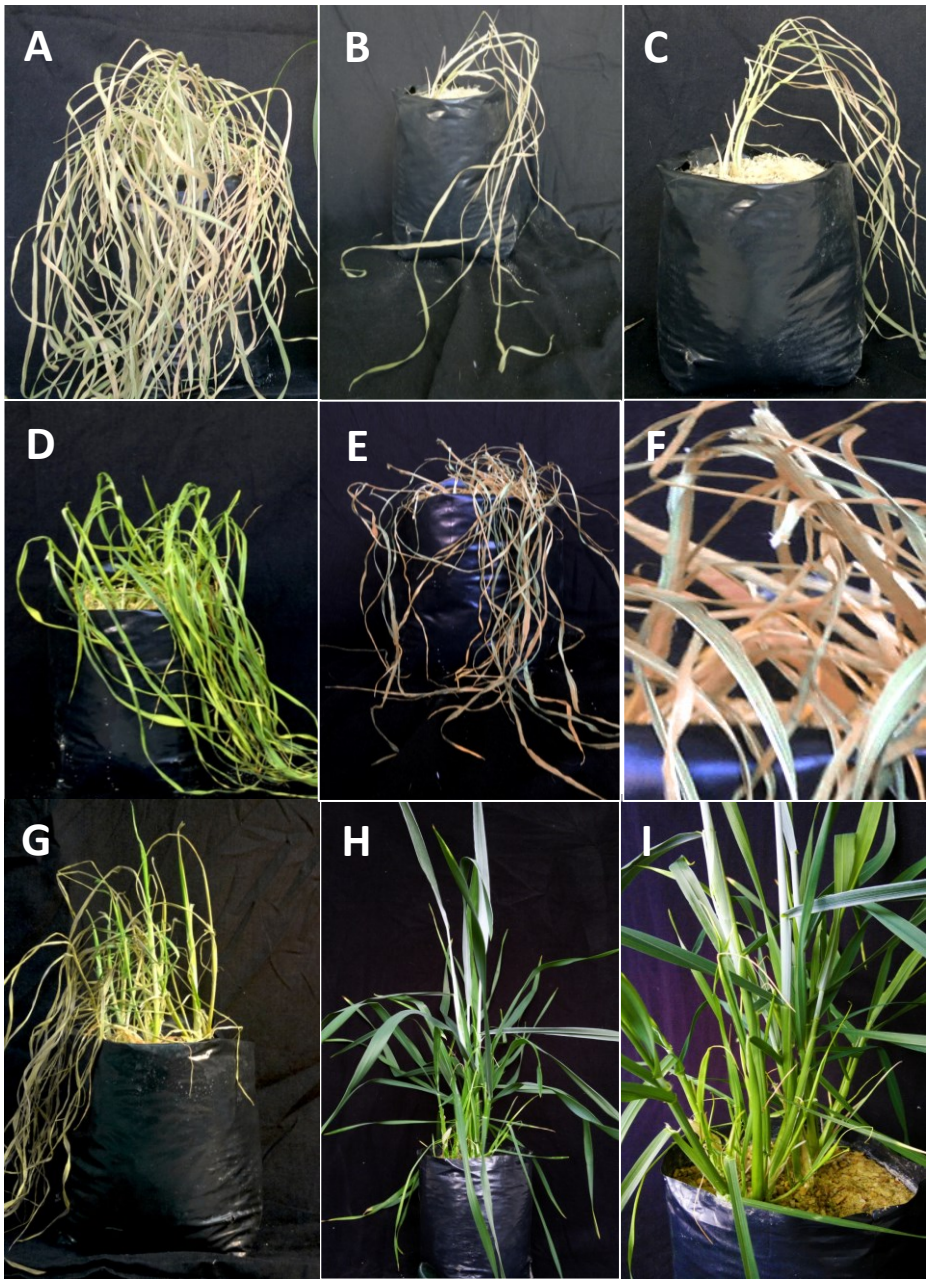

Figure 1. Phenotypic response of control and a chemically induced mutagenic line Ryno3936 after exposure to water stress. (A-C) Control plants after (A) Day 7, (B) Day 14 (C) Day 14 without watering; (D-I) Chemically induced mutant line Ryno3936 after (D) Day 7, (E, F) Day 14; and after re-watering on (G) Day 21, and after (H, I) 120 days.

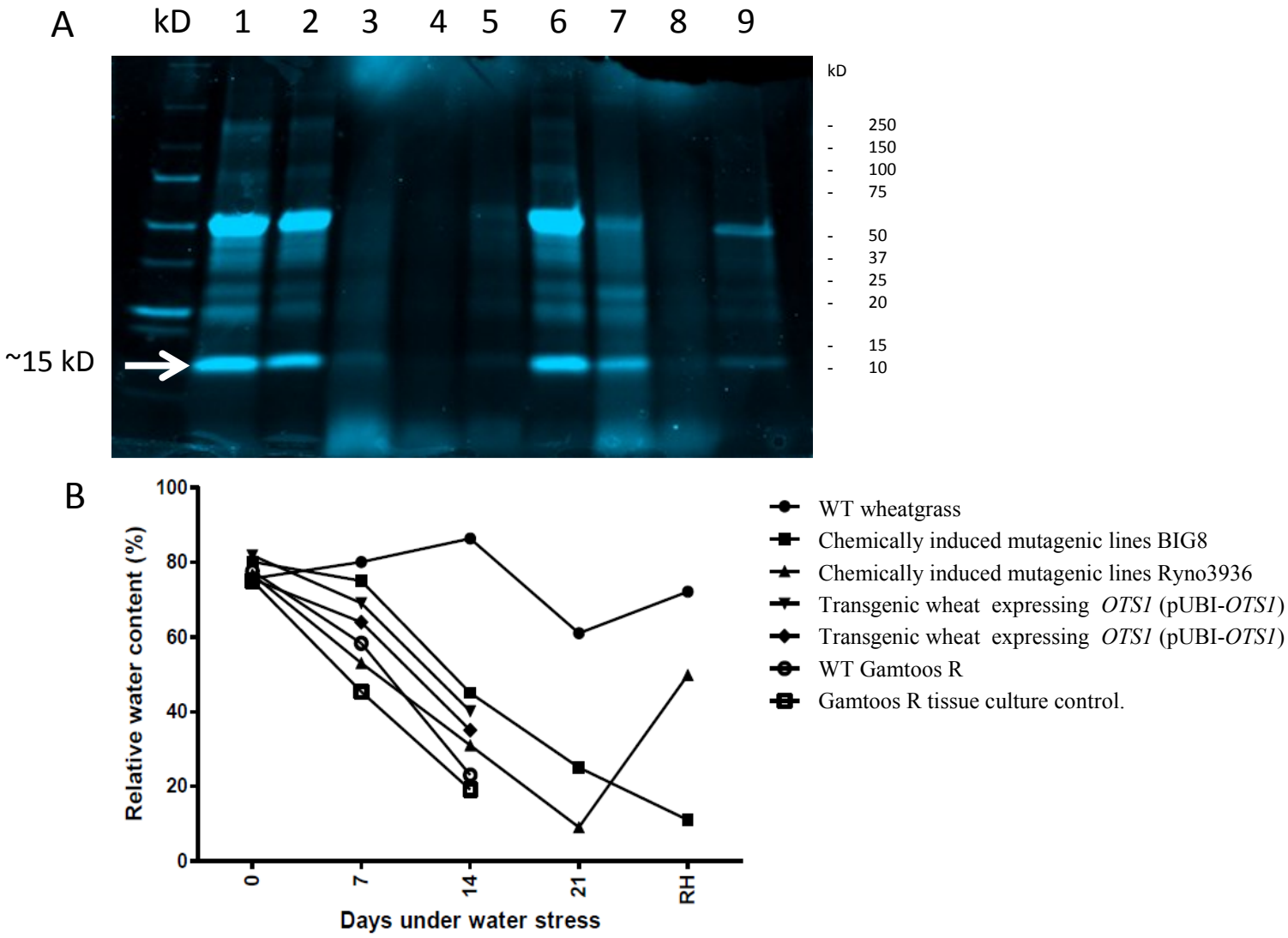

Figure 2. Responses of wheat lines exposed to different water stress regimes (0, 7, 14 days post watering, as well as 21 and 28 days post rehydration). **(A)** Protein separated on a Mini-Protein TGX gradient gel (4-15%) where lanes 1 to 2 = chemically induced mutagenic line BIG8 and lanes 6 to 9 = chemically induced mutagenic line Ryno3936. All lanes were loaded with 20 µg total protein. The arrow indicated the accumulation of free SUMO conjugates (~15 kD); **(B)** Relative water content of the different wheat lines after exposure to water deficit. Illustrated is the relative water content expressed as a percentage of total water loss. Arrow indicates time interval where most of the plants were classified as completely dehydrated (senesced) and unable to recover/regrow after watering.