Breeding grapevine for an efficient use of water by lowering night-time transpiration

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In the face of increasing water scarcity, breeding for higher transpiration efficiency (TE), that is, the biomass produced per unit of water transpired, has become crucial. This could be achieved by reducing plant transpiration through a better closure of the stomatal pores at the leaf surface. However, this strategy generally also lowers growth, as stomatal opening is necessary for the capture of atmospheric CO2 that feeds daytime photosynthesis. Here, we considered the reduction in transpiration rate at night (En), when photosynthesis is inactive, as a possible strategy to limit water use without altering growth. We carried out a genetic analysis for En and TE in grapevine, a major crop in drought-prone areas. A 3 year experiment was conducted on the F1 progeny from a cross between Syrah and Grenache cultivars using a phenotyping platform coupled to a controlled-environment chamber, under well-watered and moderate soil water deficit scenarios. High genetic variability was found for En and 5 QTLs were detected. An experiment was also performed outdoors which confirmed the significance of this genetic variability. We further highlighted a major role of residual stomatal opening at night and a minor, yet significant contribution of the cuticle in determining this genetic variability. Strikingly, 4 of the QTLs detected for En co-localized with QTLs for TE. Moreover, genotypes with favourable alleles on these common QTLs exhibited reduced En without altered growth. These original results (Coupel-Ledru et al., PNAS, 2016) open new horizons for breeding crops with lower water loss at night for higher TE.