Influence of vegetative propagation on epigenetic rejuvenation and its effect on vine response to stress: a multi-omic study

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Abstract

Plants have developed a suite of processes to endure stress conditions. Previous work has shown how the memory of stress primes plants to be more resilient to subsequent stresses, but how such priming effect is maintained in perennial plants after winter dormancy and during vegetative propagation is less studied. Here we used a multi-omic approach to determine if abiotic stress induces an epigenetic priming in grapevine, and how winter dormancy and vegetative propagation affects its maitainance. Our results showed that exposure to abiotic stress induces the expression of genes associated with epigenetic modifications during stress and after stress removal, suggesting the establishment of epigenetic memory of stress. This was further supported by primed plants showing a small number of differentially expressed genes associated with stress response even in the absence of a second stress, and presenting a stronger response than naïve plants when re-exposed to stress one year later. Similarly, plants propagated from primed mother plants using layering presented more differentially expressed genes than plants propagated using callused cuttings. Also, only primed layered propagules showed differentially expressed genes in the absence of a second stress event, suggesting that the established stress memory is, at least partially, lost during callused cutting propagation. Whole-genome bisulphite sequencing analysis showed that callused cutting propagation induces a reduction in DNA methylation similar to that observed during sexual propagation. Additionally, we observed the expression of small RNAs previously associated to plant juvenility in plants propagated using callused cuttings. Taken collectively, our results indicate that abiotic stress induces an epigenetic memory of stress, and that such memory is maintained in primed plants over a year, affecting their response to a subsequent stress. Interestingly, callused cutting propagation results in a rejuvenation of the propagule's methylome and in the loss of such memeory of stress. This work presents the first evidence of stress memory establishment in grapevine and laids the foundation to understand the importance of epigenetic mechanisms during the vegetative propagation of perennial plants like grapevine.

Keywords: Epigenetic priming, DNA methylation, small RNAs, gene expression, stress response, plant rejuvenation