An siRNA pathway prevents transgenerational retrotransposition in plants subjected to stress

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Eukaryotic genomes consist to a significant extent of retrotransposons that are suppressed by host epigenetic mechanisms, preventing their uncontrolled propagation(1,2). However, it is not clear how this is achieved. Here we show that in Arabidopsis seedlings subjected to heat stress, a copia-type retrotransposon named ONSEN (Japanese 'hot spring') not only became transcriptionally active but also synthesized extrachromosomal DNA copies. Heat-induced ONSEN accumulation was stimulated in mutants impaired in the biogenesis of small interfering RNAs (siRNAs); however, there was no evidence of transposition occurring in vegetative tissues. After stress, both ONSEN transcripts and extrachromosomal DNA gradually decayed and were no longer detected after 20-30 days. Surprisingly, a high frequency of new ONSEN insertions was observed in the progeny of stressed plants deficient in siRNAs. Insertion patterns revealed that this transgenerational retrotransposition occurred during flower development and before gametogenesis. Therefore in plants with compromised siRNA biogenesis, memory of stress was maintained throughout development, priming ONSEN to transpose during differentiation of generative organs. Retrotransposition was not observed in the progeny of wild-type plants subjected to stress or in non-stressed mutant controls, pointing to a crucial role of the siRNA pathway in restricting retrotransposition triggered by environmental stress. Finally, we found that natural and experimentally induced variants in ONSEN insertions confer heat responsiveness to nearby genes, and therefore mobility bursts may generate novel, stress-responsive regulatory gene networks.

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