Tourist_15 – a Carrot MITE Family Rewires the Circadian Clock Regulatory Network by Redistribution of LHY Binding Sites

Alicja Macko-Podgorni , Wojciech Wesolowski , Kornelia Kwolek , Natalia Piasecka , Monika Szewczyk , and Dariusz Grzebelus*[1]

[1]University of Agriculture in Krakow – Al. 29 Listopada 54, 31-425 Krakow, Poland

Abstract

One of the prominent features of transposable elements (TEs) is their ability to affect expression patterns of host genes. Upon insertion, they can provide novel *cis*-regulatory elements (CREs). Plant circadian clock regulatory network coordinates a range of important growth and cellular processes. *LATE ELONGATED HYPOCOTYL (LHY)* is one of the key regulators of the circadian clock in plants, also involved in abiotic stress responses. We searched for carrot MITE families carrying CREs. *Tourist_15* family members were highly enriched in LHY binding sites. Using DNA affinity purification sequencing (DAP-seq), we identified 11,779 LHY peaks genome-wide, of which 20% were localized in promoters. Of 2,346 genes with DAP-seq peaks within promoter regions, 74% were expressed and of those, the expression of 694 genes was affected by at least one abiotic stress.

We overlapped the experimentally identified LHY binding sites with the location of MITEs. We revealed that 1,428 (12%) of DAP peaks overlapped with MITE copies and 591 (41%) of those were within the *Tourist_15* family, comprising 56% of all copies. Positions of 163 and 73 *Tourist_15* copies bound by LHY were directly upstream or downstream the nearest gene, respectively, 35 and four were located in introns and cds, respectively, while the remaining 316 were intergenic. Expression levels of 203 genes (55% of all genes potentially controlled by CREs provided by *Tourist_15*) was affected by abiotic stresses. Of those, 123 *Tourist_15* copies resided upstream, 30 in introns, 47 downstream, and three in cds of the differentially expressed genes. Thus, *Tourist_15*s are able to redistribute LHY binding sites upon mobilization. Fifteen of the 28 PCR-assayed *Tourist_15* insertion sites were polymorphic. Thus, they might dynamically rewire the circadian clock network and possibly also accelerate adaptation of carrot to abiotic stresses.

The research was financed by the Polish National Science Center (NCN) (2019/33/B/NZ9/00757).

Keywords: Daucus carota, abiotic stress, gene expression, miniature inverted repeat transposable elements, PIF, Harbinger

*Speaker