Brief Communication

Heat shock transcription factor A1b regulates heat tolerance in wheat and Arabidopsis through OPR3 and jasmonate signalling pathway

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Dear Editor,

High temperature adversely affects plant growth and severely causes crop yield loss worldwide, especially for chenopod wheat (Triticum aestivum L.; Akter and Islam, 2017). Heat shock transcription factors (HSFs) and plant hormones play regulatory roles in plant responses to heat stress (Banival et al., 2004). In this study, we found that TaOPR3 contributes to heat tolerance in wheat probably via regulating JA level.

To elucidate the underlying mechanism responsible for the transcriptional regulation of AtOPR3 under heat stress conditions, the putative AtOPR3 promoter sequence (1500 bp) was analysed using Plant CARE interface programme. Two potential heat shock elements (HSE-1 and HSE-2) at the position of -175 bp and -903 bp were identified (Figure 1f). Interestingly, the opr3-3 T-DNA insertion is located between the two HSEs. Next, GUS reporter was fused with integral 1500-bp promoter sequence (pOPR3:GUS; including both HSE-1 and HSE-2) and with a 620 bp sequence only including HSE-1 but not HSE-2 (pdhHSE-2:GUS) (Figure 1f). Results showed that deletion of HSE-2 affects GUS expression in response to heat stress (Figure 1i).

HSEs are usually bound by HSFs to regulate gene expression (Wu, 1995). Among four hsf mutants (hsfa1a, hsfa1b, hsfa2 and hsfa3), we found that AtOPR3 transcript abundance is reduced only in hsfa1b mutant after heat treatment (Figure 1m). Next, we introduced pOPR3:GUS construct into both WT and hsfa1b mutant and found that pOPR3:GUS/WT lines expressed up-regulated GUS expression level after heat treatment, but not for pOPR3:GUS/hsfa1b lines (Figure 1n). Yeast one-hybrid assay indicated that yeast strain co-transformed with vector expressing HSFA1b plus vector containing canonic HSE-2 sequence grow on selective media (media lacking leucine and containing 200 ng/ml ABA), while strain co-transformed with mhSE-2 (a substitute of HSE-2) is unable to grow (Figure 1o).

To further shed light on the mechanisms linking JA signalling pathway with heat stress tolerance, we investigated the expression pattern of JA inducible gene DREB2A and found that DREB2A mRNA level is lower in opr3-3 than in WT after 1 h and 2 h heat treatment, (Figure 1p). Constitutively expressing DREB2A in opr3-3 mutants (3SS:DREB2A/opr3-3) exhibited enhanced heat tolerance with higher survival rate (84%-90%) than that of opr3-3 (31%) and WT (62%) after heat treatment (Figure 1q). These results suggest that JA affects heat tolerance by regulating DREB2A. We also found that the expression level of TaDREB2A is impaired in TaOPR3 RNAi lines compared with WT at 3 h, 6 h and 9 h after heat stress, whereas it is enhanced in TaOPR3 overexpression lines (Figure 1r), further indicating a potentially similar mechanism of heat stress tolerance in wheat and Arabidopsis.

Limited information is available about molecular mechanisms of the JA-mediated thermotolerance. In present study, we provide...
information which improves knowledge regarding the mechanis-
tic link between heat stress/HSFs and JA signalling pathway.
When plants perceive heat stress, HsfA1b might convert into a
functional homo-trimer (Peteranderl et al., 1999; Wu, 1995) and
activates AtOPR3 expression. This leads to increased JA biosyn-
thesis and accumulation. Subsequently, JA-mediated signalling
pathway activates a cascade resulting in increased DREB2A
expression and enhanced heat tolerance in plants. Our study
provides a potential approach to improve crop heat stress
tolerance by increasing OPR3 expression level appropriately under
heat stress conditions.

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Competing interests
The authors declare no competing interests.

Author contributions
M.X. and H.P. designed the experiments. X.T., F.W., Y.Z., T.L.,
K.Y., L.Z. and Z.Q. performed the research. Z.H., Y.Y. and Z.N.
analysed the data. Q.S. V.R., H.P. and M.X. wrote the paper.

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