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## 小麦条锈菌效应蛋白HASP2抑制寄主免疫反应

季森, 赵梦鑫, 徐静华, 汤春蕾, 康振生, 王晓杰\*

西北农林科技大学植物保护学院/旱区作物逆境生物学国家重点实验室, 杨凌 712100

### Wheat stripe rust effector HASP2 inhibits host immune response

JI Sen, ZHAO Meng-xin, XU Jing-hua, TANG Chun-lei, KANG Zhen-sheng, WANG Xiao-jie\*

State Key Laboratory of Crop Stress Biology for Arid Areas/College of Plant Protection, Northwest A F University, Yangling 712100, China

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**摘要** 由小麦条锈菌(*Puccinia striiformis* f.sp. *tritici*, *Pst*)引起的小麦条锈病是小麦上的重要病害。研究小麦条锈菌在致病过程中分泌的毒性效应蛋白分子的功能,对揭示小麦条锈菌致病机理,进而研发病害防治新方法具有重要意义。前期在小麦条锈菌吸器转录组中筛选到一个高丰度表达的分泌蛋白基因HASP2。HASP2基因全长240 bp,其编码的蛋白质N端包含22\_aa的信号肽,无跨膜区,无结构域。qRT-PCR显示HASP2在条锈菌CYR32侵染早期上调表达;农杆菌介导的烟草瞬时表达实验表明HASP2能够抑制由小鼠凋亡蛋白BAX诱导的烟草细胞坏死;利用细菌三型分泌系统(T3SS)将HASP2在小麦中过表达,发现其可以抑制寄主PTI(PAMP-triggered immunity)相关胼胝质积累;同时对HASP2过表达的小麦接种无毒性菌系CYR23后,发现HASP2可以抑制寄主ETI(Effector-triggered immunity)相关活性氧积累和减少细胞坏死面积,但HASP2过表达对条锈菌的生长发育没有显著影响。

**关键词** : 小麦, 小麦条锈菌, 效应蛋白, PTI, ETI

**Abstract:** Wheat stripe rust, caused by *Puccinia striiformis* f.sp. *tritici* (*Pst*), is an important disease on wheat. Studying the pathogenic related function of effectors is of great significance for revealing the pathogenic mechanism and new methods of prevention of wheat stripe rust. Based on analysis of the previous haustorial transcriptome of *Pst* isolate CYR32, we screened the candidate genes predicted coding secreted proteins and obtained a highly expressed gene *HASP2* which was 240 bp in length. The N-terminus of *HASP2* contained a 22-aa signal peptide with no transmembrane region and no predicted motifs. qRT-PCR analysis showed that *HASP2*

#### 作者相关文章

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was up-regulated during the initial infection stage of rust CYR32. With *Agrobacterium tumefaciens* co-infiltrations in *Nicotiana benthamiana*, HASP2 was capable of suppressing cell death triggered by mouse pro-apoptotic protein BAX. Overexpression of HASP2 in wheat using the bacterial type III secretion system (TTSS) could inhibit callose deposits that related to host PTI. In contrast, when challenged with an avirulent *Pst* isolate CYR23, effector-triggered immunity (ETI) was weakened which accompanied by reduction of reactive oxygen species (ROS) accumulation and hypersensitive response (HR) that led to the smaller areas of cell death on wheat leaves, while the abnormal growth and development of stripe rust transformants were not observed.

**Key words:** wheat wheat stripe rust effector protein PTI ETI

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