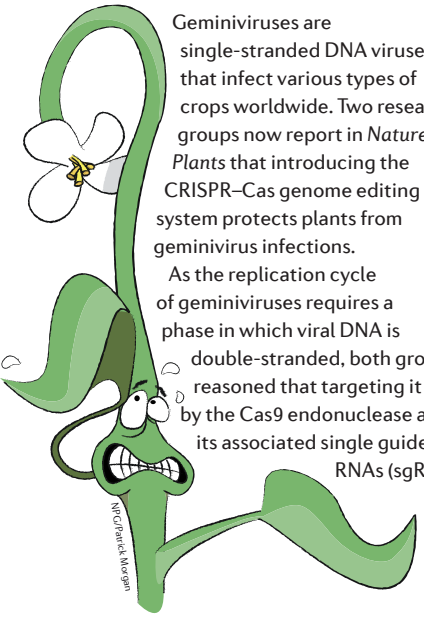
PLANT CELL BIOLOGY

CRISPR–Cas protection from plant viruses



Geminiviruses are single-stranded DNA viruses that infect various types of crops worldwide. Two research groups now report in *Nature Plants* that introducing the CRISPR–Cas genome editing system protects plants from geminivirus infections.

As the replication cycle of geminiviruses requires a phase in which viral DNA is double-stranded, both groups reasoned that targeting it by the Cas9 endonuclease and its associated single guide RNAs (sgRNAs) would inhibit viral infection. Ji *et al.* tested resistance to beet severe curly top virus (BSCTV) in *Nicotiana benthamiana* and *Arabidopsis thaliana*. They designed sgRNAs that target different sites in the BSCTV DNA and found that some sgRNA–Cas9 constructs reduced viral DNA load by up to 97%. This resulted in the systematic relief of the severe leaf-curling symptom. Baltes *et al.* designed sgRNAs against the bean yellow dwarf virus (BeYDV) DNA and achieved an 87% reduction of target DNA in *N. benthamiana*; this was improved by combining two different sgRNAs.

Next, Ji *et al.* produced several transgenic sgRNA–Cas9 *N. benthamiana* and *A. thaliana* lines, expressing different levels of Cas9, and infected them with BSCTV. Transgenic lines with lower Cas9 expression levels exhibited mild symptoms of viral infection, and lines with higher Cas9 expression levels were virus- and symptom-free. Baltes *et al.* produced and tested transgenic *N. benthamiana* lines and found that they had lower BeYDV DNA loads and mild symptoms.

> “Transgenic … lines with higher Cas9 expression levels were virus- and symptom-free”

These studies indicate that the CRISPR–Cas system has great potential for conferring plant immunity, as it can be used to simultaneously target several sites at viral genomes and/or different viruses in the same plant.

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ORIGINAL RESEARCH PAPERS Ji, X. *et al.* Establishing a CRISPR–Cas-like immune system conferring DNA virus resistance in plants. *Nat. Plants* http://dx.doi.org/10.1038/nplants.2015.144 (2015) | Baltes, N. J. *et al.* Conferring resistance to geminiviruses with the CRISPR–Cas prokaryotic immune system. *Nat. Plants* http://dx.doi.org/10.1038/nplants.2015.145 (2015)