CRISPR/dCas9 platforms in plants: strategies and applications beyond genome editing

ABSTRACT

Clustered regularly interspaced short palindromic repeat (CRISPR) and Cas9-associated protein systems provide a powerful genetic manipulation tool that can drive plant research forward. Nuclease-dead Cas9 (dCas9) is an enzymatically inactive mutant of Cas9 in which its endonuclease activity is non-functional. The applications of CRISPR/dCas9 have expanded and diversified in recent years. Originally, dCas9 was used as a CRISPR/Cas9 re-engineering tool that enables targeted expression of any gene or multiple genes through recruitment of transcriptional effector domains without introducing irreversible DNA-damaging mutations. Subsequent applications have made use of its ability to recruit modifying enzymes and reporter proteins to DNA target sites. In this paper, the most recent progress in the applications of CRISPR/dCas9 in plants, which include gene activation and repression, epigenome editing, modulation of chromatin topology, live-cell chromatin imaging and DNA-free genetic modification, will be reviewed. The associated strategies for exploiting the CRISPR/dCas9 system for crop improvement with a dimer of the future of the CRISPR/dCas9 system in the functional genomics of crops and the development of traits will be briefly discussed.

Keyword: CRISPR/dCas9; CRISPR/dCas9 ribonucleoproteins; Chromatin imaging; Chromatin topology; Epigenome editing; sgRNAs; Transcriptional activation; Transcriptional regulation