Use of CRISPR/Cas9 technology for development of disease resistant cultivar in plant breeding - A review

Bikal Ghimire, Masters Student, EMJMD Plant Health

Abstract:

Increasing population, limited land resource, climate change and outbreak of new pests and disease has imposed severe threats to crop production and global food demand challenging food security. Sustainable agriculture with gene editing technologies for breeding of disease resistant varieties seems to be key solution to these problems. (Clustered Regular Interspaced Palindromic Repeats)/Cas9 (CRISPR- associated protein) is a recent breakthrough in gene editing technology which can be utilized to exploit defensive mechanism in plants against disease attack with recognition and degradation of the invading pathogenic genes by bacterial immune system. Advances in plant breeding with integration of CRISPR/Cas9 have facilitated the production of cultivars with heritable resistance to viral and bacterial disease because of its easy to use, multi gene editing, minimal off-target effects, specificity, higher efficiency and stable heritability features (Kumar & Jain, 2014). This CRISPR/Cas9 mediated genetically engineered resistance can be inherited to further generation of crops after segregation of Cas9/sgRNA transgene in F1 generation to prevent undesirable genome modification in successive generation with maintenance of disease resistant genome in the crops (Zhang & Zhou, 2014). The possibility of segregation of Cas9/sgRNA after development of disease resistant plants makes use of CRISPR/Cas9 safer in plant breeding. With its higher efficiency it replaces conventional breeding which is time consuming process for making crosses, back crosses and selection of progenies. CRISPR/Cas9 system proves itself as a fascinating tool to revolutionize plant breeding for the development of various disease resistant cultivars.

Image:

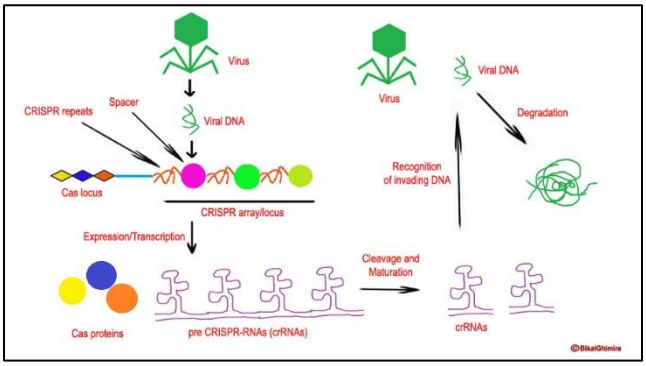


Figure 1. Working mechanism of CRISPR/Cas9 system. When a CRISPR containing organism recognizes the invading DNA as nonself, it takes a fragment of it and incorporates that fragment in the spacer between CRISPR repeats. The Cas genes located in the upstream or vicinity of CRISPR array is transcribed to produce Cas proteins and pre CRISPR-RNAs (pre crRNAs). These pre crRNAs are cleaved by Cas proteins and undergo maturation to form crRNAs. These crRNAs can immediately recognize the invading DNA which has strong match with its spacer and act against invading DNA by cleaving them to degrade. The cleavage of invading DNA protects the host and provides immunity. The figure is based on study of CRISPR/Cas9 system in various literatures and review.

Recent Publications:

1. Ghimire, B., & Timsina, D. (2015). Analysis of Yield and Yield Attributing Traits of Maize Genotypes in Chitwan, Nepal. World Journal of Agricultural Research, 3(5), 153-162.
2. Ghimire, B., Timsina, D., & Nepal, J. (2015). Analysis of chlorophyll content and its correlation with yield attributing traits on early varieties of maize (Zea mays L.). Journal of Maize Research and Development, 1 (1), 134-145.



Bikal Ghimire is Erasmus Mundus Master Student following the program EMJMD Plant Health. He completed his bachelor's degree from Tribhuvan University, Nepal. Mr. Ghimire is always passionate about researches on molecular techniques involving disease resistance in agricultural crops. He completed his first year of Master's degree from University of Goettingen, Germany and currently doing his second year in University of Padova, Italy.

Email: anzealex@gmail.com