HSPI Inc. The Open Access Publisher

A F N S ISSN 2575-0194 ARCHIVE OF FOOD AND NUTRITIONAL SCIENCE

Short Communication

Role of CRISPR-Cas9 in agricultural science

Prodipto Bishnu Angon*

Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Abstract

Clustered regularly interspaced short palindromic repeat (CRISPR), a potent gene-editing tool was found in 2012. CRISPR is a genetic engineering technique that enables genome editing in living creatures and is based on the bacterial CRISPR-Cas9 antiviral defense mechanism. It is simpler, less expensive, and more accurate than previous gene editing techniques. It also has a wide range of valuable uses, including improving crops and treating genetic diseases. Plant science has benefited more from the CRISPR/Cas9 editing technique than medical science. CRISPR/Cas9 has been used in a range of crop-related research and development domains, including disease resistance, plant development, abiotic tolerance, morphological development, secondary metabolism, and fiber creation, as a well-developed cutting-edge biotechnology technique. This paper summarized the role of the CRISPR-CAS9 tool in modern agricultural science.

More Information

***Address for correspondence:**
Prodipto Bishnu Angon, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh,
Email: angonbishnubau@gmail.com

Submitted: November 25, 2022
Approved: December 22, 2022
Published: December 23, 2022

How to cite this article: Angon PB. Role of CRISPR-Cas9 in agricultural science. Arch Food Nutr Sci. 2022; 6: 090-091.

DOI: 10.29328/journal.afns.1001043

Keywords: CRISPR; Agriculture; Gene editing; Modern tool; Plant modification

Introduction

The goal of modern agricultural technology is to grow more crops on the same amount of land [1,2]. The biggest issue in the modern world is climate change. Globally, the temperature is rising steadily as a result of climate change. The sector of agriculture is affected by many forms of stress, including intense cold or heat, salinity, and waterlogging. In this setting, there is a greater need for food production due to the expanding population [3]. It is now possible to alter the genomic sequence of different crops using the CRISPR-Cas9 technique. As a result, the crops can withstand salinity, drought, or waterlogging. The crop can no longer be harmed by those pressures [4]. In all crops, new varieties are being created utilizing the CRISPR-Cas9 system which is more sophisticated and productive than before. CRISPR-Cas9 technology has also been used on a growing number of monocot and dicot plant species to increase their productivity, quality, nutritional value and tolerance to biotic and abiotic stresses [5]. The objective of this review is to know the role and future prospective of the CRISPR-Cas9 gene editing tool Figure 1.

CRISPR-Cas9 role in plant science

The CRISPR-Cas9 technique has been used on a variety of plants, including *Brassica oleracea, Hordeum vulgare, Cucumis sativus, Glycine max, Citrus sinensis, Nicotiana tabacum, Solanum lycopersicum, Oryza sativa, Solanum tuberosum, Triticum aestivum, Sorghum bicolor, Zea mays, Vitis vinifera, etc* [6,7].

Pathogen, such as: *Magnaporthe oryzae* and *Xanthomonas oryzae pv. oryzae (Xoo)*, which causes serious damage to the rice plants [8,9]. Tomato, citrus, orange, cucumber, and cotton can defend against pathogens, *Pseudomonas syringae, Xanthomonas citri, Xanthomonas citri subsp. citri (Xcc)*, cucumber vein yellowing virus, and *Verticillium dahliae*, respectively. The CRISPR-Cas9 technique used Agrobacterium transformation to knock out the targeted genes [8,10].

To make crops resistant to abiotic stress, the CRISPR-Cas9 method edited or knocked out the targeted gene. *The AGROS8* gene for maize and the *PPa6* gene for rice are the most popular examples. G-gene deletion (*gs3* and *dep1*) allows rice to withstand salt stress [5]. When the *ppa6* gene was knocked

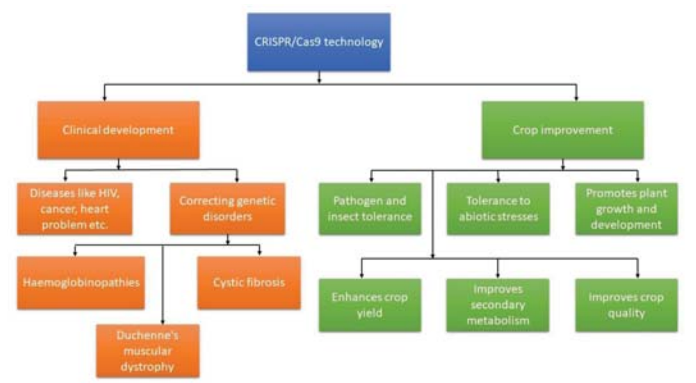

Figure 1: Role of CRISPR-Cas9.

out, rice exhibited increased alkaline stress resistance [11]. The CRISPR/Cas9 technology, which eliminated the *OsDST* gene, was used to create rice that can withstand salt and drought [12].

In rice, *gw2, gw5*, and *tgw6*, negative regulators of grain weight, were knocked out using CRISPR-Cas9 technology; mutants produced as a result of genome editing have increased grain size and weight. CRISPR-Cas9-edited mutants of *GASR7* increased the grain weight of wheat. CRISPR-Cas9 edited cis-regulatory element *CLV-WUS* was used to increase tomato fruit size [13].

Conclusion

Although there are several potential uses for CRISPR/Cas9 technology in crop breeding, there are still certain restrictions. Since these features are necessary for employing this instrument, a significant obstacle is the small number of genes affecting crucial agronomic parameters. In this context, there is a pressing need to understand genomic sequence data and investigate premium genetic resources for agricultural enhancement. From this, it is understood that the role of CRISPR-Cas9 in crop development is immense. In the future, the use of CRISPR-Cas9 technology in the agriculture sector will be widespread, and it is now a matter of time.

References

1. Eş I, Gavahian M, Marti-Quijal FJ, Lorenzo JM, Mousavi Khaneghah A, Tsatsanis C, Kampranis SC, Barba FJ. The application of the CRISPR-Cas9 genome editing machinery in food and agricultural science: Current status, future perspectives, and associated challenges. Biotechnol Adv. 2019 May-Jun;37(3):410-421. doi: 10.1016/j.biotechadv.2019.02.006. Epub 2019 Feb 16. PMID: 30779952.
2. Gao C. The future of CRISPR technologies in agriculture. Nat Rev Mol Cell Biol. 2018 May;19(5):275-276. doi: 10.1038/nrm.2018.2. Epub 2018 Jan 31. PMID: 29382940.
3. Ricroch A. Global developments of genome editing in agriculture. In Transgenic research. 2019; 28: 45-52.
4. Rao MJ, Wang L. CRISPR/Cas9 technology for improving agronomic traits and future prospective in agriculture. Planta. 2021 Sep 8;254(4):68. doi: 10.1007/s00425-021-03716-y. PMID: 34498163.
5. Angon PB, Habiba U. Application of the CRISPR/Cas9 gene-editing System and Its Participation in Plant and Medical Science. Current Applied Science Technology. 2023; 10-55003.
6. Liu Q, Yang F, Zhang J, Liu H, Rahman S, Islam S, Ma W, She M. Application of CRISPR/Cas9 in Crop Quality Improvement. Int J Mol Sci. 2021 Apr 19;22(8):4206. doi: 10.3390/ijms22084206. PMID: 33921600; PMCID: PMC8073294.
7. Liu X, Wu S, Xu J, Sui C, Wei J. Application of CRISPR/Cas9 in plant biology. Acta Pharm Sin B. 2017 May;7(3):292-302. doi: 10.1016/j.apsb.2017.01.002. Epub 2017 Mar 11. PMID: 28589077; PMCID: PMC5443236.
8. Le VT, Kim MS, Jung YJ, Kang KK, Cho YG. Research Trends and Challenges of Using CRISPR/Cas9 for Improving Rice Productivity. Agronomy. 2022; 12(1): 164.
9. Mehta S, Lal SK, Sahu KP, Venkatapuram AK, Kumar M, Sheri V, Reddy MK. CRISPR/Cas9-edited rice: a new frontier for sustainable agriculture. In New frontiers in stress management for durable agriculture. Springer, Singapore. 2020; 427-458.
10. Bhowmik P, Konkin D, Polowick P, Hodgins CL, Subedi M, Xiang D, Kagale S. CRISPR/Cas9 gene editing in legume crops: Opportunities and challenges. Legume Science. 2021; 3(3): e96.
11. Hu W, Kaminski R, Yang F, Zhang Y, Cosentino L, Li F, Luo B, Alvarez-Carbonell D, Garcia-Mesa Y, Karn J, Mo X, Khalili K. RNA-directed gene editing specifically eradicates latent and prevents new HIV-1 infection. Proc Natl Acad Sci U S A. 2014 Aug 5;111(31):11461-6. doi: 10.1073/pnas.1405186111. Epub 2014 Jul 21. PMID: 25049410; PMCID: PMC4128125.
12. Santosh Kumar VV, Verma RK, Yadav SK, Yadav P, Watts A, Rao MV, Chinnusamy V. CRISPR-Cas9 mediated genome editing of drought and salt tolerance (OsDST) gene in indica mega rice cultivar MTU1010. Physiol Mol Biol Plants. 2020 Jun;26(6):1099-1110. doi: 10.1007/s12298-020-00819-w. Epub 2020 May 10. PMID: 32549675; PMCID: PMC7266915.
13. Zhang D, Zhang Z, Unver T, Zhang B. CRISPR/Cas: A powerful tool for gene function study and crop improvement. J Adv Res. 2020 Oct 21;29:207-221. doi: 10.1016/j.jare.2020.10.003. PMID: 33842017; PMCID: PMC8020163.